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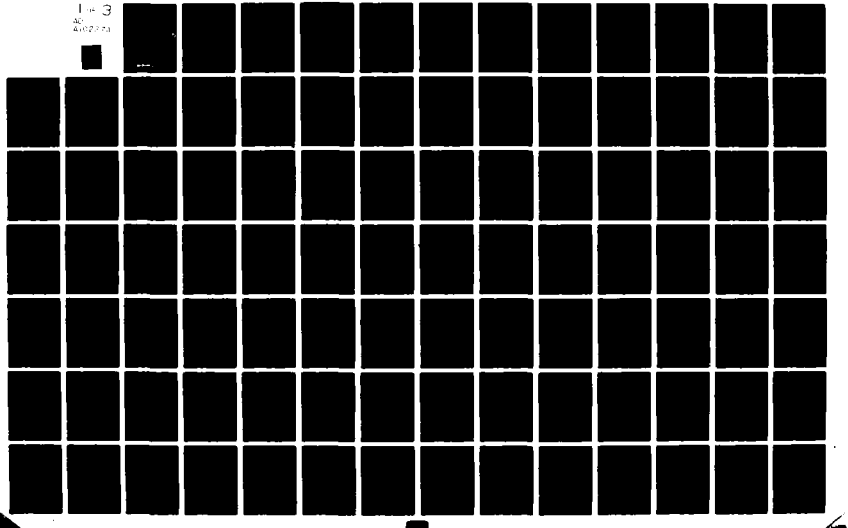

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COST AND TRAINING EFFECTIVENESS ANALYSIS PERFORMANCE GUIDE

Richard K. Matlick
Melvin H. Rosen
Doris C. Berger

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September 1980

Prepared for U.S. Army Research Institute for the Behavioral and Social Sciences Under Contract MDA 903-79-C-0326 Monitored by Dr. Charles C. Jorgensen.

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20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides procedural guidance for Army personnel tasked with the conduct of Cost and Training Effectiveness Analyses (CTEA). It provides strategies for planning the CTEA and provides illustrative methods to be adapted to the particular data availability situations of the CTEA analyst. The report includes a Training Cost Model.

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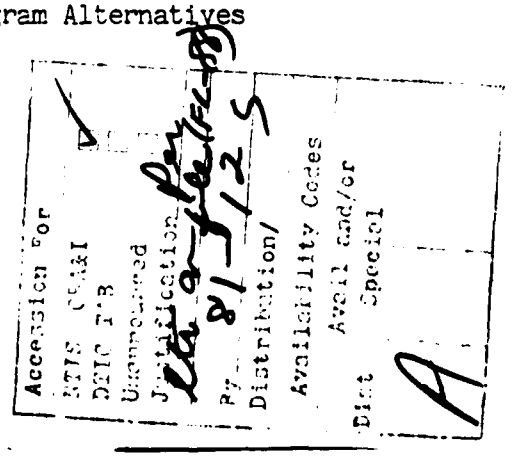

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HOW TO USE THIS PERFORMANCE GUIDE

1. Determine the purpose of your CTEA; e.g., does the CTEA have to be a complete cost and training effectiveness analysis or is it only to resolve some specific issue or issues? (See Section I.)

2. Refer to the General CTEA Model (Figure II-1) to help you assess what data are available to you. (See also the text in paragraph IIB starting on page II-3.)

3. Determine the specific issues that require resolution. (See discussion in paragraph IIC starting on page II-5 and Table II-2 on page II-16.)

4. Study the series of strategies for performing CTEA discussed in paragraph IID starting on page II-6.

5. Proceed to Table II-3 (page II-17), "How to Proceed from Here."

SECTION I

INTRODUCTION

A. Purpose of this Performance Guide

This is a "how to" manual. It shows an analyst how to perform cost and training effectiveness analyses (CTEA) during Weapon System Acquisition required by the Life Cycle System Management Model (LCSMM) and other related regulations and documents. The Manual assumes that the analyst has a working knowledge of Army training and task anaysis but may not be an expert in these fields or in psychology or in mathematics.

You will note throughout the Guide the frequent use of the word "estimate." Whatever the method for CTEA, you will be dealing in estimates rather than with exact measures and you should be guided accordingly. In other words, it will not be worth your while to strive for greater accuracy in your analyses than the input data warrant.

B. Purposes of the CTEA

1. Evaluation of the ease/difficulty of training system tasks.

CTEAs supply evaluations of the training subsystems at several points in the process of system acquisition. The evaluations allow system performance to be judged (and acquisition decisions made) based on estimates of soldiers' proficiency on the various tasks. The CTEA thereby identifies those tasks likely to be difficult to train, providing the Army with a basis for requesting modifications in the hardware or in the tasks.

2. Determination of the relative merits of alternative training plans.

Where alternative training plans have been proposed, the CTEA assesses the likelihood of each plan producing soldiers trained to criterion level or that level at which they perform the tasks to the required standards. The comparison of alternatives is done for each task or group of tasks, enabling a choice of the more effective plan or a combination of the more effective elements of several plans.

3. Identification of likely components of an optimal training program.

The CTEA examines the critical tasks to be performed on a developing system and determines the training methods most likely to produce the required proficiency in the soldier.

4. Determination of training subsystem costs.

The CTEA determines the cost of training soldiers to proficiency on the critical tasks of the system. The impact of training subsystem cost on the total cost of the system can thereby be evaluated. The determination also permits cost comparisons among proposed alternative training subsystems.

C. CTEA Products

1. The CTEA produces an estimate of the effectiveness of training for each task or group of tasks, e.g., the percentage of trainees achieving criterion level on a test of performance for each task (such as SQT or end-of-course test).

2. The CTEA produces a table of relative effectiveness or merit, comparing proposed alternative training plans (when available) for each critical task. The table may be defined in terms of relative proficiency measures or in terms of the proportion of necessary training elements or variables included in the alternative plans.

3. The CTEA produces a list of those training elements or variables deemed necessary and, depending on the method or approach selected, may show training deficiency (where a training requirement is not matched by the training program), training excess (where training elements in the training program are not required by the task description), or training redundancy (where two or more media or methods meet the same need).

4. The CTEA produces an estimate of the costs involved in training the soldier to operate and/or maintain the system in the field.

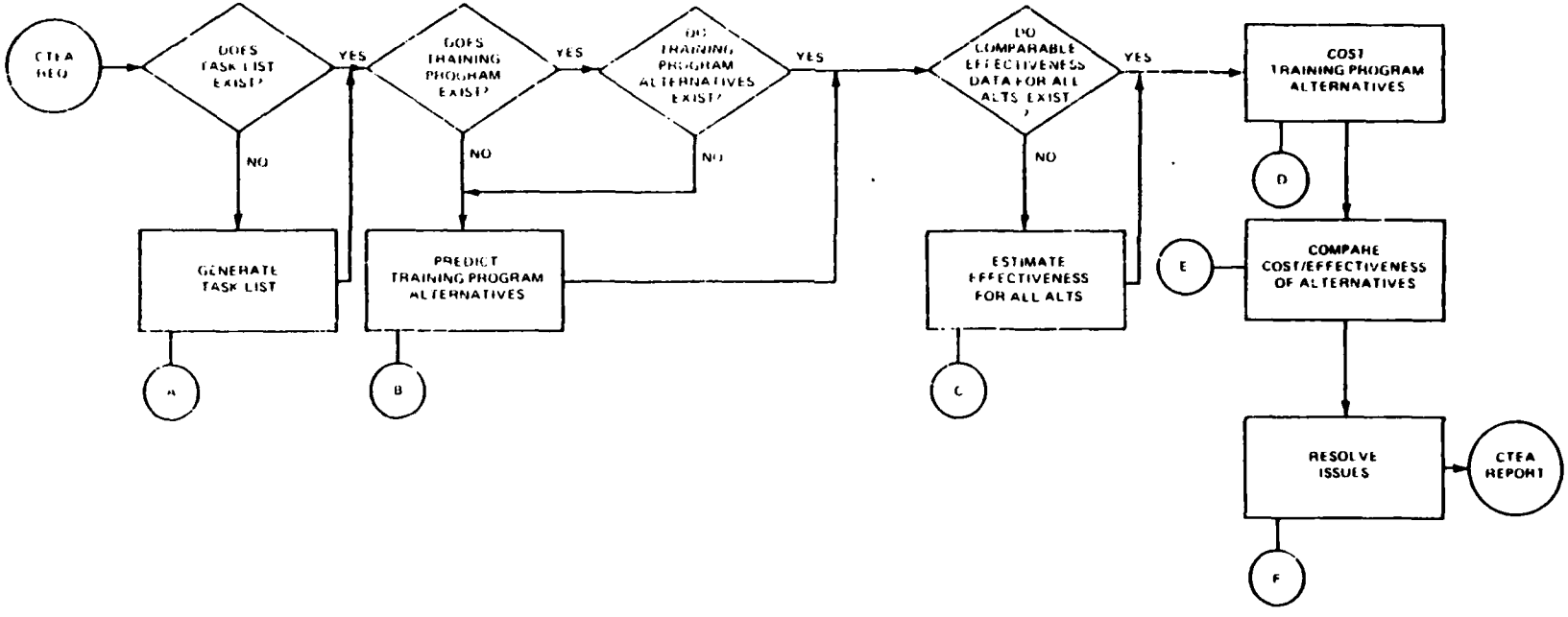
SECTION II

PLANNING THE CTEA

A. Overview

Various methods have been developed for performing CTEA. The inputs and outputs of these methods differ as do the advantages and disadvantages of each. The general approach in this Guide is to break the CTEA down into its component processes and then to apply that method which maximizes the advantages and minimizes the disadvantages for a particular process.

Whatever the location of the CTEA within the LCSM, the selection of methods for the accomplishment of its various analytical processses is controlled primarily by the available data. The issues to be resolved and the questions to be answered by the CTEA must also influence the selection of methods once the nature of the relevant data has been determined. Thus, method selection begins with the identification of the basic analytical processes made necessary by the relative sparseness or richness of the data and then proceeds to the selection of ways to accomplish those processes. After these initial selections, the means of addressing the specific issues and questions of the CTEA must be considered. This approach to the selection of CTEA methods is illustrated in Figure II-1 and further explained below.



LEGEND LETTERS IN CIRCLES REFER TO ANALYTICAL PROCESSES IN TABLE II-1

Figure II-1. General CTEA Model

B. Assessment of Available Data

How well a CTEA can be done and, to some extent, where in the system acquisition process it should be done are highly dependent on the amount and types of data available. As the system progresses through the acquisition process, more and better data become available. The necessary data will probably not be readily available and you will have to look for it. Perhaps the most difficult task in the CTEA will be data collection -- especially in the early stages of system acquisition. This will be particularly true of cost data.

Once the performance of a CTEA has been directed, you must first ask whether a training program (including tasks to be trained, methods to train tasks, personnel to be trained, locations of training for various tasks, etc.) actually exists. Depending on the answer to this question, your analysis will proceed along one of two primary tracks (Figure II-1).

1. If there is no training program, determine if there is a task list complete enough to permit design or prediction of alternative training programs (at least for the mission-critical tasks).

- o If there is no such task list, or if it is not complete enough to develop alternative training programs, a task list must be generated.
- o Once a task list has been generated, or you have determined that a complete enough task list exists, select a method or methods for the training prediction process.
- o After selecting these methods, select methods for the remaining processes:
  - o estimation of effectiveness
  - o costing of training program alternatives
  - o cost effectiveness comparisons of training programs
  - o resolution of issues

2. If there is a training program, analysis will proceed along the other primary track (Figure II-1).

- o Determine if there are performance data complete enough and valid enough to permit empirical evaluation (based on actual performance) of the effectiveness of the training program alternatives.
  - o If there are no such data, select a method or methods for estimating effectiveness.
  - o If there are performance data, determine if these are based on a single program or on a set of program alternatives.

- If there are no such alternatives, determine how to predict or develop alternatives, and

- determine how to estimate the effectiveness of the alternatives.

o Once you have made these decisions, proceed, as in paragraph 1 above, to select methods for the remaining processes:

  o costing of training program alternatives

  o cost effectiveness comparisons of training programs

  o resolution of issues

C. Issues Requiring Resolution

The issues which you must address in order to assist the decision-makers vary with the particular phase of the system acquisition process. During Phase I, Conceptual, the main questions will probably be:

- To what extent is the basic concept trainable?
- What training program elements (e.g., delivery approach, media) should be included in the program?
- What is the estimated cost of training the required number of people to proficiency on the system?

As more data become available in Phase I with the development of the Letter of Agreement (LOA) and organizational and operational concepts, the CTEA can be updated. You should now consider issues such as:

- What is the relative trainability of alternative concepts?
- What is the relative cost of effectiveness of the training programs for the alternative concepts?

As the acquisition process moves into Phase II, Demonstration and Validation, more data become available, such as Section V (Training Plan) of the Outline Acquisition Plan (OAP) and the results of DT/OT I. The issues of trainability and relative cost effectiveness of alternatives remain. Now, however, your CTEA should resolve the issue of necessary revisions of the training programs. As the Provisional Qualitative and Quantitative Personnel Requirements Information (PQQPRI) becomes available, you will want to update your CTEA to help resolve the issues of training device requirements (TDR) and the relative cost effectiveness of the revised training programs. Trainability of these programs remains an issue.

When the acquisition cycle moves into Phase III, Full Scale Development, enough additional data should have been generated to warrant another CTEA. Events that provide the additional data are the beginning of New Equipment Training (NET) based on the NET Plan, approval of the Acquisition Plan (AP), the results of DT/OT II, the evaluation of the effect the new system will have on ARTEP, draft training programs, and field manuals (FM). The primary issues to be resolved by this CTEA are:

- the performance data from DT/OT II versus the standards of performance developed in the training plans and documents
- the impact of the performance data on hardware and training -- program design, personnel selection, hardware modification, etc.

This CTEA should be updated in Phase IV, Production and Development, based on DT/OT III Reports, revisions of training plans and programs (e.g., SQT, ARTEP), FM, and Section V of the DP. An update may be occasioned during deployment if there is a product improvement or modification program. The primary issue to be addressed in this phase is the cost effectiveness of the revised program.

D. Strategies for Conducting the CTEA

In order to assist you in conducting the CTEA and selecting methods to perform the CTEA, the following strategies or general plans have been developed. While they do not cover every conceivable situation, they do cover those situations that can be reasonably expected to occur.

Strategy 1

Situation: There is no training program and there is no complete task list.

Processes Required by the General CTEA Model:

- o Generation of a task list
- o Prediction of training programs
- o Estimation of effectiveness
- o Costing of training programs
- o Comparison of training program alternatives
- o Resolution of issues

Elements:

o Generation of a task list. Determine the status of the task information and choose an appropriate method. If the CTEA is to be done early in an acquisition program -- that is, during the conceptual phase -- a rudimentary task list may be adequate though it should be as refined as is possible within CTEA study resources. The "generic CTEA" processes used for the DIVAD Gun may be useful. If tasks can be inferred from a contractor's draft TM or from knowledge of an antecedent system, use a process like the HAWK Product Improvement Program (PIP) Training Development. If the CTEA is to be done in a later stage of acquisition -- demonstration and validation phase or later -- a rudimentary task list probably will not be adequate, and considerable effort should go into producing a refined task list. If you have detailed knowledge of the antecedent system, use the ROLAND Training Development Process to generate the task list. (See Table II-1).

o Prediction of training program alternatives. Predict or estimate training program alternatives in several ways. Estimate one training program on the basis of expert knowledge of the weapons or materiel system under investigation or expert knowledge of the class of weapons or materiel systems to which the developing system belongs. Then use an analytical method such as the Training Efficiency Estimation Model[1] (TEEM) or the Modified Training Effectiveness, Cost Effectiveness Prediction Technique (TECEP)[2] to predict one or more alternatives. (See Table II-1.)

---

[1]Jorgensen and Hoffer, Prediction of Training Programs for Use in Cost Training Effectiveness Analysis, 1978.

[2]Braby et.al., A Technique for Choosing Cost-Effective Instructional Delivery Systems, TAEG Report No. 16, 1975.

Table II-1. REQUIRED ANALYTICAL PROCESSES AND CANDIDATE METHODS

A GENERATION OF TASK LIST	B PREDICTION OF TRAINING PROGRAMS	C ESTIMATION OF EFFECTIVENESS	D COSTING OF TRAINING PROGRAMS	E COMPARISON OF TRAINING PROGRAM ALTERNATIVES	F RESOLUTION OF ISSUES
DIVAD GUN (III A1)*	TEEM (III B1)	TEEM (III C1)	LITTON COST	TEEM (III E1)	ITV (III E1)
HAWK PIP (III A2)	TECEP (III B2)	DIVAD GUN	MODEL (III D)	TCA (III E2)	DRIMS (III E2)
ROLAND (III A3)	DIVAD GUN	(III C2)	(modified TAEG 16)	BDM/CARAF	TRAINABILITY
	(III B3)	ATM (III C3)		(III E3)	ANALYSIS (III E3)
	ATM (III B4)	TRAINVICE		DIVAD GUN (III E4)	
		(III C4)		DRIMS (III E5)	
		TCA (III C5)		ATM (III E6)	
				TECEP (III E7)	

*Numbers and letters in parenthesis indicate the paragraph of the performance guide where you will find this method for this process.

Such a procedure allows the products of expert judgment to be compared with the products of analytical methods and vice versa. Wide differences in the training programs predicted or estimated by two such divergent methods can identify areas that require closer examination.

o Estimation of effectiveness. In the case of a training program estimated on the basis of expert knowledge, estimate effectiveness also on the basis of expert knowledge. If a task under examination is similar to a task in an existing system about which the analyst has knowledge, and if it is known that a certain training approach results in the required level of proficiency on the task, the training approach may be estimated to be roughly as effective in training the new task as in training the existing task. If the Analogous Task Method (ATM, a formal analytical procedure) has been used to predict a training program alternative, use it also to estimate the effectiveness of that program. If TEEM has been employed to estimate two or more alternatives, the efficiency ratios become the estimates of effectiveness. No matter how the training program alternatives have been predicted or estimated, Training Consonance Analysis (TCA)[3] may be used to estimate effectiveness. The training consonance ratios (TCR) produced by the method become the estimates of effectiveness. (See Table II-1.)

o Costing of training program alternatives. Use the modified TECEP (TAEG #16) Cost Model to estimate costs[4]. Any cost model that yields satisfactory cost estimates may be used, but this one is automated, comprehensive, and apparently satisfactory for Army acquisition decisions. (See Table II-1 and Section IIID, p. III-77.)

o Comparison of training program alternatives. Compare training programs first on the basis of estimated cost and estimated effectiveness. Form cost/effectiveness (C/E) ratios (estimated cost over estimated effectiveness, but all estimates must be in the same terms, i.e., produced by the same method) and tentatively choose the lower value since it represents the lowest or lower cost per "unit" of effectiveness. Decide which estimated level of effectiveness is acceptable (not totally a judgmental process; see TEEM) and eliminate or revise alternatives with a lower estimated effectiveness. Defer final selection or recommendation of a training program alternative until all issues have been resolved. It may be, for example, that the training program with the highest C/E value may be the best choice when considered in the light of training risk. This would be the case if a training program were estimated to be more effective in training certain high-risk tasks but were also estimated to be somewhat more costly than the next best program. Possible impacts of training risk may indicate that the more effective program is worth the higher costs. Refer to Table II-1 and read the techniques referred to under Column F, Resolution of Issues. These issues may correspond to yours or similar techniques may be useful in resolving the issues you must address.

o Resolution of issues. Identify issues or questions (frequently referred to as EEA for essential elements of analysis) not already resolved by the preceding processes, and choose or develop approaches to them. These approaches may include recommendations for further studies or tests. (See Table II-1.)

---

[3]Hawley and Thomason, Development of an Air Defense Cost and Training Effectiveness Analysis Methodology, 2 vol., 1978.

[4]The modification of the cost model is a Litton modification (see Section IIID).

Strategy 2

Situation: There is no training program but there is a complete task list.

Processes Required by the General CTEA Model:

- o Prediction of training programs
- o Estimation of effectiveness
- o Costing of training programs
- o Comparison of training program alternatives
- o Resolution of issues

Elements:

o Prediction of training program alternatives. As in Strategy 1, estimate training program alternatives in several ways, including both informal methods based on expert judgment and formal analytical methods such as TEEM, TECEP, ATM, and DIVAD Gun. Compare the results of the various methods and resolve differences. Be aware that if the analyst faces the situation very early in an acquisition program, the training program predictions or estimations need not be as precise as they will need to be at later stages. Still, make predictions or estimations as precisely as the task information permits. (See Table II-1.)

o Estimation of effectiveness. Estimate effectiveness as in Strategy 1. Be aware that the state of the task information (a rudimentary task list, a somewhat refined task list, or a set of fully developed task statements) determines the precision with which training programs may be predicted or estimated and their effectiveness estimated.

o Costing of training programs. Cost training programs as in Strategy 1. Be aware that the precision or accuracy of cost estimates depends on the precision or accuracy of estimation of training programs. (See Table II-1.)

o Comparison of training program alternatives. Compare training program alternatives as in Strategy 1.

o Resolution of issues. Resolve issues as in Strategy 1. Because the situation that this strategy addresses is likely to occur during the concept exploration phase of an acquisition program when competing materiel concepts are being explored, be especially aware that the issue of trainability is important. (See Table II-1.)

Strategy 3

Situation: There is a training program but there are no alternatives and no effectiveness data.

Processes Required by the General CTEA Model:

- o Prediction of training programs
- o Estimation of effectiveness
- o Costing of training programs
- o Comparison of training program alternatives
- o Resolution of issues

Elements:

o Prediction of training program alternatives. Use a formal analytical procedure such as TEEM, TECEP, or ATM to predict training program alternatives to be compared with the existing training program. A method based on informal expert knowledge may also be used, but because of the method to be used in the comparison of training program alternatives the details and relative precision of the formal analytical procedures will be useful. Whatever the method employed, consider different levels of training device/media usage, especially levels different from those in the existing program, and different methods. (See Table II-1.)

o Estimation of effectiveness. Use TCA to estimate the effectiveness of both the existing training program and the predicted training programs. This method yields both values (TCRs) which may be taken as estimates of effectiveness and diagnostic information (training deficiencies, excesses, and redundancies) which may be used to recommend revisions of the existing training program. A method based on expert knowledge/judgment may also be employed, but because one training program actually exists while the alternatives have only been predicted (i.e., described) the possibility of biased estimates exists. (See Table II-1.)

o Costing of training programs. Cost training programs as in Strategy 1. Because one training program to be costed actually exists while the alternatives have only been predicted or estimated, be aware that cost estimates must be comparable in level of detail and precision if valid cost comparisons are to be made. (See Table II-1.)

o Comparison of training program alternatives. Compare training program alternatives using the TCRs as estimates of effectiveness. Combine alternatives on the basis of effectiveness and costs. Form cost/effectiveness (C/E) ratios as in Strategy 1 and tentatively choose the lowest or lower value since it represents the lowest or lower cost per "unit" of effectiveness. Then note the relationship of the TCRs: if the TCRs of one or more predicted alternatives are higher than the TCR of the actual training program, compare the media and methods of the predicted alternatives -- task by task -- with the media and methods of the actual training program. Also examine the actual training program in light

of its own diagnostic information (training deficiencies, excesses, and redundancies) and the diagnostic information pertaining to predicted alternatives with higher TCRs. This information can be used to recommend revisions of the actual training program that will cause its TCR and thus its estimated effectiveness to increase. The adoption of one of the predicted alternatives may also be recommended, should comparison of C/E values warrant, but defer final selection or recommendation of a training program until all issues have been resolved. See comparison of training program alternatives in Strategy 1.

o Resolution of issues. Resolve issues as in Strategy 1. Necessary revisions of the existing training program are likely to constitute an important issue, but the resolution of it will have been accomplished during the comparison of training program alternatives.

Strategy 4

Situation: There is a training program with effectiveness data but there are no alternatives.

Processes Required by the General CTEA Model:

o Prediction of training programs

o Estimation of effectiveness

o Costing of training programs

o Comparison of training program alternatives

o Resolution of issues

Elements:

o Prediction of training program alternatives. Predict training program alternatives as in Strategy 3.

o Estimation of effectiveness. Estimate the effectiveness of all alternatives (the existing training program and the predicted alternatives) as in Strategy 3. There are effectiveness data for the existing training program, probably performance measures from DT/OT, but the comparison of alternatives requires a common measure, and this can be provided only through estimates of effectiveness such as TCRs. The TCRs and associated diagnostic information will be used in comparison of training program alternatives as a basis for recommending changes in the existing training prgram or the adoption of an alternative.

o Costing of training programs. Cost training programs as in Strategy 1. Be aware that cost estimates must be comparable in level of detail and precision if valid cost comparisons are to be made.

o Comparison of training program alternatives. If the effectiveness data of the existing training programs are performance measures (from DT/OT), determine if there are associated task/training objective standards or test criteria.

If there are none, proceed as in Strategy 3, comparison of training program alternatives. If there are standards or test criteria, determine if the performance measures represent a deficiency in training, the required level of training proficiency, or an excess of training. Next, examine the TCA diagnostic information of the existing training program to tentatively determine how that training program could be revised to reduce or eliminate training deficiencies or excesses in training. Then, determine which of the predicted alternatives have TCRs higher than the TCR of the existing training program and compare these alternatives -- task by task -- with the existing training program in order to establish a further basis for recommending revisions of the existing training program or selection of an alternative. Finally, form C/E ratios as in Strategy 1, comparison of training program alternatives, and tentatively select the program with the lowest or lower C/E value since the program represents the lowest cost per "unit" of effectiveness. But if standards or criteria exist and the existing training program represents a training deficiency, the existing training program in its unrevised form must be eliminated from selection. Compute a TCR for the existing training program revised as recommended, revise the cost estimate accordingly, and form a new C/E ratio. Compare the C/E values of the predicted alternatives with the new C/E value. Again, choose the lowest or lower C/E values, but be aware that the cost estimates of predicted alternatives must include all development costs while the cost estimate of the existing training will include fewer development costs or perhaps none at all. If the selection finally made is an existing training program with excesses or redundancies, use the TCA diagnostic information to make recommendations for revisions to further increase the cost effectiveness. Defer final selection or recommendations of a training prgram or training program revision until all issues have been resolved.

o Resolution of issues. Resolve issues as in Strategy 1, but be aware that training device requirements (TDR) will likely constitute an important issue and a method for predicting or considering TDR must therefore be selected or developed.

Strategy 5

Situation: There are training program alternatives but not effectiveness data for all alternatives.

Processes Required by the General CTEA Model:

- o Estimation of effectiveness
- o Costing of training programs
- o Comparison of training program alternatives
- o Resolution of issues

Elements:

o Estimation of effectiveness. Estimate the effectiveness of all existing alternatives as in Strategy 3. If all alternatives are to be compared, including those without effectiveness data, this is a necessary step.

o Costing of training programs. Cost all existing training program alternatives as in Strategy 1.

o Comparison of training program alternatives. If the effectiveness data for two or more alternatives are performance measures associated with task/training objective standards or test criteria, first eliminate from consideration those alternatives whose performance measures show that their effectiveness is unacceptable. Then compare the remaining alternatives on the basis of cost and effectiveness. Form C/E ratios and tentatively select the training program with the lowest or lower C/E value since it represents the lowest cost for acceptable effectiveness. If the effectiveness data are not performance measures or if there are no associated standards or criteria, proceed as in Strategy 3, comparison of training program alternatives. If there are performance measures with associated task/training objective standards or test criteria for only one training program, proceed as in Strategy 4, comparison of training program alternatives. If the first case identified above prevails, compare all alternatives on the basis of TCRs (from TCA). If a training program alternative without performance measures has a higher TCR than the training programs with performance measures, consider that that program may be more effective than the programs with performance measures and recommend the collection of performance measures to verify that greater effectiveness. If the first case identified above prevails and the measures of performance include more than one measure of training effectiveness (MOTE), then use BDM/CARAF[5] to compute a total weighted effectiveness score and use this value to form a C/E ratio. Defer final selection or recommendation of a training program until all issues have been resolved. (See Table II-1.)

o Resolution of issues. Resolve issues as in Strategy 1. Be aware that performance versus standards and performance versus hardware, training program design, and personnel selection are likely to constitute issues to be resolved.

Strategy 6

Situation: There are training program alternatives and effectiveness data for all alternatives.

Processes Required by the General CTEA Model:

o Costing of training programs

o Comparison of training program alternatives

o Resolution of issues

Elements:

o Costing of training programs. Cost all training program alternatives as in Strategy 1.

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[5]BDM Services Company/Combined Arms Research and Analysis Facility (BDM/CARAF), Cost and Training Effectiveness Analysis Handbook for Action Officers, 1976.

o Comparison of training program alternatives. This strategy assumes that all effectiveness data are comparable and that effectiveness data are performance measures associated with task/training objective standards or test criteria. Should the assumption not be true, one of the other strategies will be applicable. First eliminate from consideration those alternatives whose performance measures show that their effectiveness is unacceptable. (If all alternatives are thus eliminated from consideration, use TCA for diagnosis and recommend revision and further testing of programs.) Then compare the remaining alternatives on the basis of cost and effectiveness. Form C/E ratios and tentatively select the training program with the lowest or lower C/E value since it represents the lowest cost for acceptable effectiveness. If the measures of performance include more than one measure of training effectiveness (MOTE), then use BDM/CARAF to compute a total weighted effectiveness score and use this value to form a C/E ratio. If factors other than performance measures are to be considered in the selection of an alternative, follow the Diagnostic Rifle Marksmanship Simulators (DRIMS) CTEA[6] method. Defer final selection or recommendation of a training program until all issues have been resolved. (See Table II-1.)

o Resolution of issues. Resolve issues as in Strategy 1. Be aware the central issue is likely to be the cost/training effectiveness of the much-revised training program of a system in the production and deployment phase of acquisition. Performance versus standards and performance versus hardware, training program design, and personnel selection may also be issues to be resolved.

[6]USAIS, Diagnostic Rifle Marksmanship Simulators Cost and Training Effectiveness Analysis, 1978.

E. Summary

Table II-2 is a summary table for CTEA in the LCSMM. Table II-3 is an overview of how to proceed from here.

Table II-2. CTEA in the LCSMM

LCSMM PHASE	CTEA	PRIMARY LCSMM EVENTS YIELDING DATA TO CTEA	ISSUES REQUIRING RESOLUTION	CTEA PROCESSES PROBABLY REQUIRED	CANDIDATE STRATEGIES
CONCEPT EXPLORATION	I	• MENS • INITIATION OF TRAINING PLANNING • INITIATION OF LOGISTICS SUPPORT PLANNING	• TRAINABILITY OF BASIC CONCEPT • COST OF TRAINING • TRAINING PROGRAM ELEMENTS TO BE INCLUDED OR STUDIED	A, B, C, D, E, F	1, 2
	I A (update)	• LOA • ORGANIZATIONAL AND OPERATIONAL CONCEPTS	• TRAINABILITY OF ALTERNATIVE CONCEPTS • RELATIVE COST EFFECTIVENESS OF TRAINING PROGRAMS OF ALTERNATIVE CONCEPTS	A, B, C, D, E, F	1, 2, 3
DEMONSTRATION AND VALIDATION	II	• OAP • DT/OT I	• TRAINABILITY • NECESSARY REVISIONS OF TRAINING PROGRAMS • RELATIVE COST EFFECTIVENESS	B, C, D, E, F	2, 3, 4
	II A (update)	• PQQPRI • DCP(IPS)	• TRAINABILITY • TDR • RELATIVE COST EFFECTIVENESS OF REVISED TRAINING PROGRAMS	B, C, D, E, F	2, 3, 4
FULL-SCALE ENGINEERING DEVELOPMENT	III	• NET PLAN • AP • DT/OT II	• PERFORMANCE VERSUS STANDARDS • PERFORMANCE VERSUS HARDWARE AND TRAINING PROGRAM DESIGN, PERSONNEL SELECTION, ETC.	D, E, F	4, 5, 6
PRODUCTION AND DEPLOYMENT	IV (update)	• TRAINING PLAN UPDATE • DRAFT TRAINING PROGRAM • AP • DT/OT III	• COST EFFECTIVESS OF REVISED TRAINING PROGRAM	D, E, F	4, 5, 6

TABLE II-3

HOW TO USE PROCEED FROM HERE

- Determine your "strategy." See discussion of strategies above and refer to Table II-2.
- Examine the processes required and methods recommended for your strategy. Refer to the processes in Section III and methods to perform them.
- Select an appropriate method for each process required by your strategy.
  - Generation of a task list
  - Prediction of training programs
  - Estimation of effectiveness
  - Costing of training programs
  - Comparison of training program alternatives
  - Resolution of issues
- Apply the methods

SECTION III

PROCESS PROCEDURES

A. Generation of Task List

1. DIVAD Gun

You may be faced with a situation where you have no task list and, apparently, no data on which to base the generation of such a list. A CTEA, however, may still be required as necessary to the milestone decisions of the acquisition process.

Use your own subject matter expertise or find a subject matter expert (SME) to help you develop a list of "generic" tasks. For example, if the developing system is an air defense system (such as DIVAD Gun), you can be fairly certain that a basic task will be "engage enemy aircraft." You can also be fairly certain that a basic task will be "maintain the system," etc. If you have any information on or familiarity with the developing system, you can then develop more detailed tasks. In other words, there are certain tasks or kinds of tasks that are common to systems of a similar class, and there is considerable information available about the training of those tasks.

This method of task list generation is somewhat of a last resort based on the situation where even the most tentative and tenuous CTEA is preferable to no CTEA.

2. Improved Hawk (Hawk PIP) Training Development

You may be required to generate a task list for a system modification or product improvement program (PIP). Where you have a system modification, many of the tasks of the modified system will be identical to those of the basic system, and the training, training requirements, and training implications will also be the same. Where tasks have been added or changed, however, (through the addition of a materiel subsystem, for example) you must define new tasks.

In the Hawk PIP training development tasks were inferred from the manufacturer's draft TM material. For example, the manufacturer's draft TM (see Figure III-1) states, "When estimating raid size of the lock, determine the number of targets in an assignment ... through d below." This task implies that there is a task, "determine raid size using the Tracking Adjunct System. (TAS)."

If you still have difficulty, you may have to request the actual equipment (as was done in Hawk PIP) in order to work out problems on the operational system.

3. Roland Training Development

a. Given such data as the manufacturer's Logistic Support Analysis Record (LSAR) D Sheets and draft TM (and, if possible as in the case of Roland training development, attendance at the manufacturer's training course), develop a task selection work sheet similar to the one in Figure III-2.

Table 3-25. Operating Procedures Performed at the FC—Continued

Step	Operation Normal indications
18.	If cease fire is in effect, continue; otherwise, proceed to step 23. The CEASE FIRE label is illuminated.
19.	When estimating raid size after lock, determine the number of targets in an assignment by monitoring the doppler audio and PPI video. Report the number by pressing either the ONE, FEW, or MANY pushbutton by using the criteria in *a* through *d* below. **NOTE** [1]For TAS equipped IHAWK batteries both the TAS visual and non-TAS criteria detailed below should be used. **NOTE** [1]For IHAWK batteries without TAS, only the non-TAS criteria should be used.
a.	When only one target is visible on the TASdisplayor when only one target is heard in the doppler audio tone, and the target video on the PPI is unbroken, press the ONE pushbutton. The ONE pushbutton on the firing console and the ONE label on the IBCC status indicator illuminate.
b.	When two targets are visible on the TASdisplayor when there is more than one target heard in the doppler audio tone, and the target video on the PPI is unbroken, press the FEW pushbutton. The FEW pushbutton on the firing console and the FEW label on the IBCC status indicator illuminate.
c.	When there are more than two targets visible on the TASdisplayor when there are many targets heard in the doppler audio tone, and the target video on the PPI is broken into many targets, press the MANY pushbutton. The MANY pushbutton on the firing console and the MANY label on the IBCC status indicator illuminate.
d.	Continue to monitor the status of the engagement by observing that the doppler audio tone remains steady and the COAST label extinguishes. Report any irregular indications.
e.	Continue to monitor the target on the TASdisplay. Report target type, weapons store, and target maneuver, if discernible.
20.	If more than one target is visible on the TAS display:
a.	Manually acquire an outlying target (a target at the edge of the formation) using the small gate target acquisition procedure (step 16).
b.	Press the TAS SLAVED/INDEP indicator-switch to SLAVED.
c.	Press the TAS PI ON/PI OFF indicator-switch to PI ON.

Figure III-1. Reproduction of Page from Manufacturer's Draft TM

TASK SELECTION WORKSHEET

MOS 16G

PAGE 1 OF 12

No. Performing	COIP	TLD
6-Majority	6-Most Serious	6-Extremely hard to learn
5-Many	5-Serious	5-Hard to learn
4-Some	4-Moderately Serious	4-Somewhat hard to learn
3-Few	3-Minimal Consequences	3-Easy to learn
2-Minimal no.	2-Trivial	2-Very easy to learn
1-One	1-No Consequences	1-Common knowledge
Time Spent Perf	**T/T**	**Task Frequency**
6-Very much	6-Least tolerance	6-Several times daily
5-Above average	5-Minimal tolerance	5-Once a day
4-Slightly above avg	4-Moderately tolerant	4-Once a week
3-Average	3-Tolerant	3-Once or twice a month
2-Below average	2-Very tolerant	2-Infrequently
1-Almost never	1-Extremely tolerant	1-Never

| TRUTH TABLE | | |

b. Go through the tasks on the LSAR D Sheets and find them in the draft TM. The draft TM will usually be a refinement and expansion of the LSAR tasks. List the tasks on the task selection worksheet. Ask the manufacturer (through appropriate channels) to explain where necessary.

c. Apply your subject matter expertise and military judgment to rating these tasks on the worksheet for:

(1) Number of people performing the task (column c)

(2) Time spent in performing the task (column d)

(3) Consequences of inadequate performance (COIP) (column e)

(4) Task delay tolerance (TDT) or effect on mission if not done in time (column f)

(5) Task learning difficulty (TLD) (column g)

(6) Task frequency or how often the task is performed (column h)

d. In columns i-n, place an x in each task cell for the tasks that scored at least the number shown in the column heading. For example, in column i for task #1, place an x if the column c entry is 5 or 6. It is 5 so an x is shown. For column j the criterion is that column d entry be 4 or higher. The column d entry for task #1 is 3 so enter a 0. Do this for all tasks.

e. Refer to the "Truth Table" at the top right of the worksheet. Find the horizontal line of X's and 0's that corresponds to the pattern of X's and 0's you have entered for the task. The "Truth Table" then gives you the entries for that task for columns o-r:

(1) column o: is the task critical?

(2) column p: should the task be taught as resident instruction or extension instruction?

(3) column q: should the task be included in the ARTEP?

(4) column r: should the task be included in wartime training?

f. Complete the Matrix Task Inventory such as the one shown in Figure III-3.

MATRIX TASK INVENTORY R=66 E=128 1

Roland Critical Task MOS 16G TASK/CATEGORY P = Perform S = Supervise X = Applicable	SKILL LEVEL 1	2	3	TRAINING SITE Resident	Extension	Included ARTEP	War Time Training	CTSB agree	CTSB Disagree
1. Perform Exterior Ground Level Inspection (PMCS	P	P	S	X					
2. Inspect Road Idler Wheels	P	P	S		X				
3. Inspect Final Drive	P	P	S		X				
4. Inspect Track End Connector & Pads	P	P	S		X				
5. Inspect Inverter Access Panel	P	P	S		X				
6. Inspect Condensor Fan Outlet	P	P	S		X				
7. Inspect Environmental Control Unit (ECU)	P	P	S		X				
8. Inspect Rear Cabin Door	P	P	S		X				
9. Inspect ECU Fresh Air Filter	P	P	S		X				
10. Inspect ECU Return Air Filter	P	P	S		X				
11. Inspect Prime Power Unit (PPU) Elapsed Time Meter	P	P	S		X				
12. Inspect Carrier Lights	P	P	S		X				
13. Inspect PPU	P	P	S		X				
14. Inspect External Pwr Connector	P	P	S		X				
15. Inspect Communication Binding Posts	P	P	S		X				
16. Inspect Emergency-Off Cover	P	P	S		X				
17. Inspect PPU Day Tank Drain Valve	P	P	S		X				
18. Inspect PPU Main Fuel Tank	P	P	S		X				
19. Inspect Coolant Level	P	P	S		X				
20. Inspect Oil Level	P	P	S		X				
21. Inspect Fan/Alternator Drive Belts	P	P	S		X				
22. Inspect Power Junction Box	P	P	S		X				
23. Inspect Fire Unit Hull	P	P	S		X				
24. Inspect Carrier Air Filter	P	P	S		X				
25. Inspect Front Carrier Lights	P	P	S		X				
26. Inspect Wheel Hubs/Shock Absorbers	P	P	S		X				
27. Inspect Track Adjuster	P	P	S		X				

FS Form 1159b (USAADS) 25 Mar 75 Previous editions of this form are obsolete. AFPD-PET

Figure III-3. Matrix Task Inventory

B. Prediction of Training Programs

Certain kinds of learning are facilitated by particular types of training. The kinds of learning required are determined from a study of the learning objectives and, more positively, the action verb in the task statement. It is this action verb that is the major clue as to what it is that the soldier must do. Several methods have been developed that assist the analyst in designing an instructional delivery system based on training objectives and their supporting kinds of learning. We will first look at those that can help the process of predicting training program alternatives.

1. TEEM (Jorgensen and Hoffer, Prediction of Training Programs for Use in Cost Training Effectiveness Analysis, 1978)*

In the early stages of development new systems have no training programs to serve as a basis of comparison. In the case of truly innovative systems, furthermore, there are no analogous systems with training programs that could provide base cases. A predictive computerized model for CTEA use has thus been developed by Jorgensen and Hoffer (1978). Their methodology, called TEEM for Training Efficiency Estimation Model, begins with task analysis, proceeds through selection of training media and methods, identifies information content and structure, and, finally, generates a cost/effectiveness ratio for use in CTEA. Iterations of the model may be made for various training weapon system options in order to produce cost/effectiveness ratios for comparison.

In this model the trade-offs made during the generation of an estimated training program are recorded. These are used to determine the potential decision cost loss for the chosen training program as compared with an ideal program with no constraints. That is, an ideal, unconstrained program is quantified and then compared with a similarly quantified real-world (constrained) training program. This measure provides a standard of comparison for several training programs generated with the same CTEA method and has potential advantages not only for the comparison of alternative programs for a given weapon system but also for comparison across systems.

The measure, the efficiency ratio, represents a value composed of the efficiency score of an estimated program with real world constraints divided by the efficiency score of an idealized program with no constraints. Outputs of this method also include a costed training program. Input is a task list along with sufficient knowledge of the weapon system to permit inferences about the nature of stimuli, responses, and feedback.

TEEM uses sets of variables to describe both the tasks to be learned and the means for training them (media and methods). The authors plan to add other variables in the future, but TEEM can be used to develop or predict training programs as it is currently constituted. Once the tasks and the means for learning have been described in terms of the same variables, matching is possible. Thus, when each variable in the description of the task is matched by the corresponding variable in the descriptions of the training program, an ideal training program has been identified. That is, for each stimulus, response,

*The procedures herein have been taken from or adapted from the cited Jorgensen-Hoffer report.

and feedback requirement implied by the tasks, there is a medium-method combination in the training program to meet the need. But because of costs and other constraints such an ideal training program cannot be achieved. Rather, as the result of designing a training program within real-world constraints something less than an ideal program is actually achieved. The difference is expressed by an efficiency ratio that will be explained in Section IIIC.

The task variables you will deal with fall within three classes: stimuli or cues, response or answering action to the stimulus, and feedback or information to the operator concerning results of his action. In addition, there are method and media variables. Procedures for using these variables to predict or develop training programs are discussed in the context of the following example.

a. Start with a task description. If there is none, you will have to generate the task list (see Section IIIA, above). For illustrative purposes, we will use the following task description:

Task:

Perform subsystem equipment failure reconfiguration using DTM-9-1430-650-10, Chapter 2, under task condition levels 1 and 2, within three minutes.

1. Detect console malfunction by observing Plan Position Indicator (PPI) displays.

2. Upon detection of malfunction, use keyboard printer unit (KPU) to select alternate console.

3. Analyze keyboard "TMON" printouts to verify correct operation.

b. Compare the task description to the variables listed under "Media Related Variables -- Stimuli Characteristics," Annex A, Appendix 1. Note that comparison of the task and variables list 1-7, shows only variable 1 to be applicable. Because variables 2-7 do not apply, they can be eliminated, along with variables 25-30, which apply to audio stimuli only. Variables 8-24 and 31-39 must now be screened for their applicability to the task description. If a variable is shown to be applicable it is scored with a 1, and if it is shown to be non-applicable, it is scored with a 0. These scores are kept on separate coding sheets, like the one shown in Figure III-4.

The example task description involves observation of PPI displays. Normally, the "Visual Forms," variables 8-13, which can be presented on PPI displays, include alphanumeric, symbolic, and graphic material (8, 9, and 10), but do not include other forms, such as pictorial, solid object, or environmental scenes (11, 12, and 13). Variables 8, 9, and 10 would each be coded as 1 on the coding sheet, while variables 11, 12, and 13 would be coded as 0. A similar procedure is used for all applicable variables. For instance, stimuli found on PPI displays may change at any time, and are, therefore, not static (31). Stimuli presented on the radar displays are also quite random (33), rather than ordered (32). Therefore, variables 31 and 32 would be scored with a 0 and 33 would be scored with a 1. Once the entire list of of applicable variables has been screened and scored on the coding sheet, using the above procedure, the

CODING SHEET

SELECTION MATRIX TYPE	VARIABLE NUMBERS																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0
2	0	0	1	0	0	1	0	0	1	0	0	1	1	0	1	0																							
3	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	1	0																						
4	0	0	1	1	1	1	0	0	1	1	0	1	0																										

1 = Applicable Variable 0 = Non-Applicable Variable

Selection Matrix Type: 1 - Media Selection - Stimulus Variables

2 - Media Selection - Response Variables

3 - Media Selection - Feedback Variables

4 - Method Selection - Functional Context Variables

Figure III-4. Coding Sheet

task will have been described in terms of the variables for the stimulus situation. (See the first row of the Sample Coding Sheet, Figure III-4 for the applicable variables for this sample task.)

c. Now compare the task description to the variables listed under "Media Related Variables -- Response Characteristics" in Appendix 2 to Annex A. Only the physical properties of the equipment which receive the operator's response to the stimulus are considered. In this example, note that the operator's response is an overt one, i.e., visible, and involves the manipulation of buttons on the KPU. Thus, variables 1, 2, 4, and 5 are coded as a 0, and 3 is coded as a 1 on the coding sheet. Likewise, the responses are not major physical movements and are coded as weak intensity responses (6). The trainee is manipulating equipment, the responses he produces will be dynamic-ordered (9) and the equipment must be capable of accepting such a response. Similarly, the response rate would probably be fast (12), the number of response channels, limited (13), and the response distribution, individual (15). (See the second row of the Sample Coding Sheet for the applicable variables for this sample task.)

d. Now code the task in the same manner for feedback variables, Appendix 3 to Annex A. In this example, the medium of information is written form (3). The source of feedback is intrinsic (not visible from the outside) (10), the type of feedback is both response consequences (14) and system status (15), and the feedback distribution is again individual (16). (See third row of the Sample Coding Sheet for the applicable variables for this sample task.)

e. After you have recorded the task information in terms of variables directly related to equipment choice, one other evaluation is required. The group of tasks must now be recoded in terms of functional context (expected operational environment) variables for method. Because this example only deals with a single task, this coding is somewhat artificial, since normally a method would not be chosen for a single task situation, but rather the overall functional context within which a cluster of related tasks would be performed. The method variables are found in Appendix 4.

Coding the task for method requires the same logic used to code the media. For this sample task, the role performed by the operator in the real environment is individual performance (3). The functions performed in the role are primarily mental in terms of analyzing the "TMON" printouts (4), physical in terms of selecting an alternate console (5), and perceptual in terms of observing PPI displays (6). The function is basically stable (9), since it does not change often. The impact of the physical context (10) and psychological context (12) is low. (See the fourth row of the Sample Coding Sheet for the applicable variables for this sample task.)

f. Appendix 5 is a listing with complete descriptions of 38 items of training equipment and materials each of which is numbered. Figure III-5 is a matrix which shows the numbers of the item of training equipment and materials across the top versus the 39 stimuli variables connected with media in the left column. A "1" has been entered in each cell where that particular medium matches the corresponding stimulus. You are now ready to begin the medium selection process.

(1) Determine from Figure III-4, Coding Sheet, which of the numbered stimulus variables you have decided are relevant to the task (or grouping

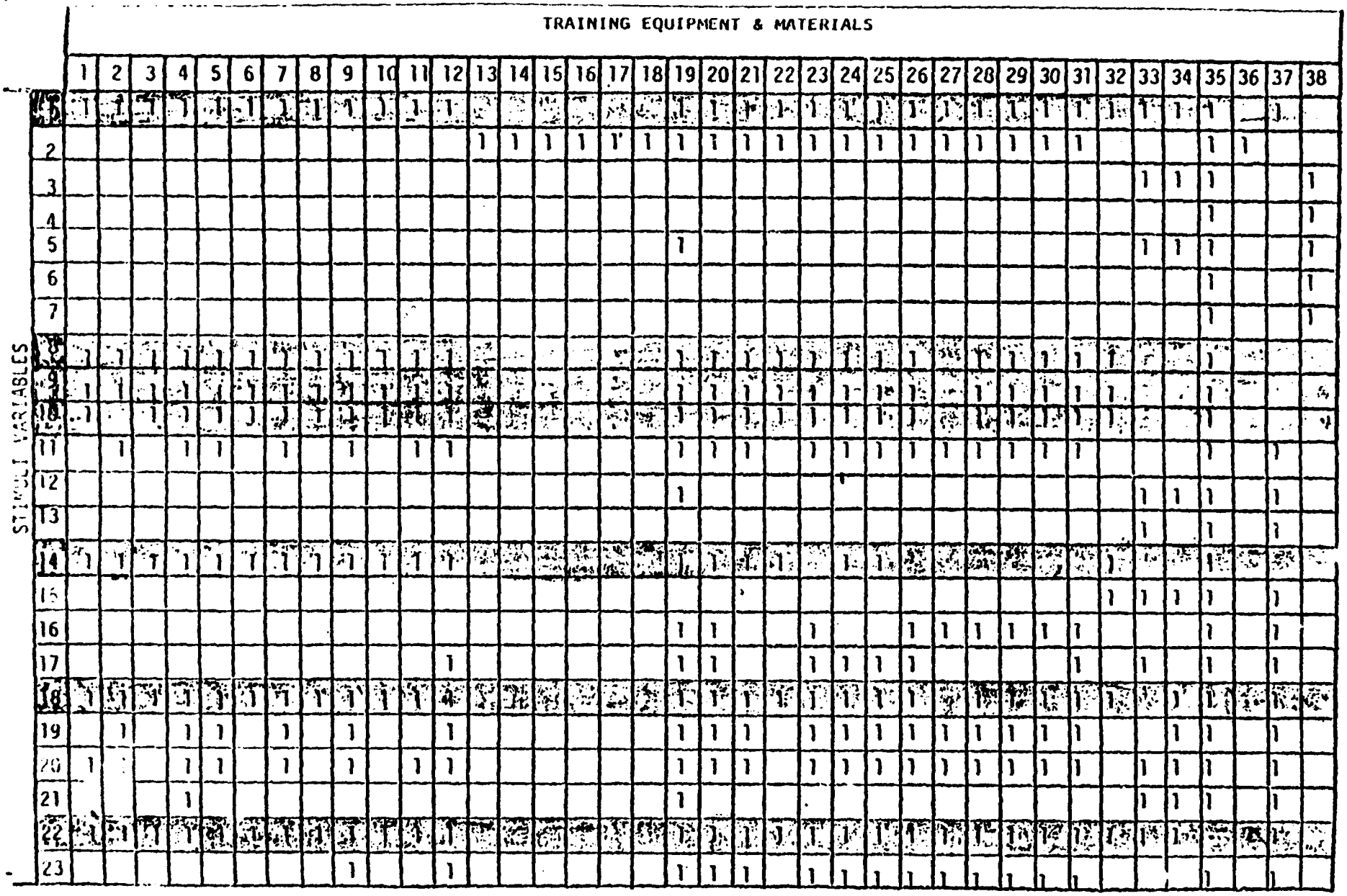

Figure III-5. Training Equipment and Materials versus Stimuli Variables

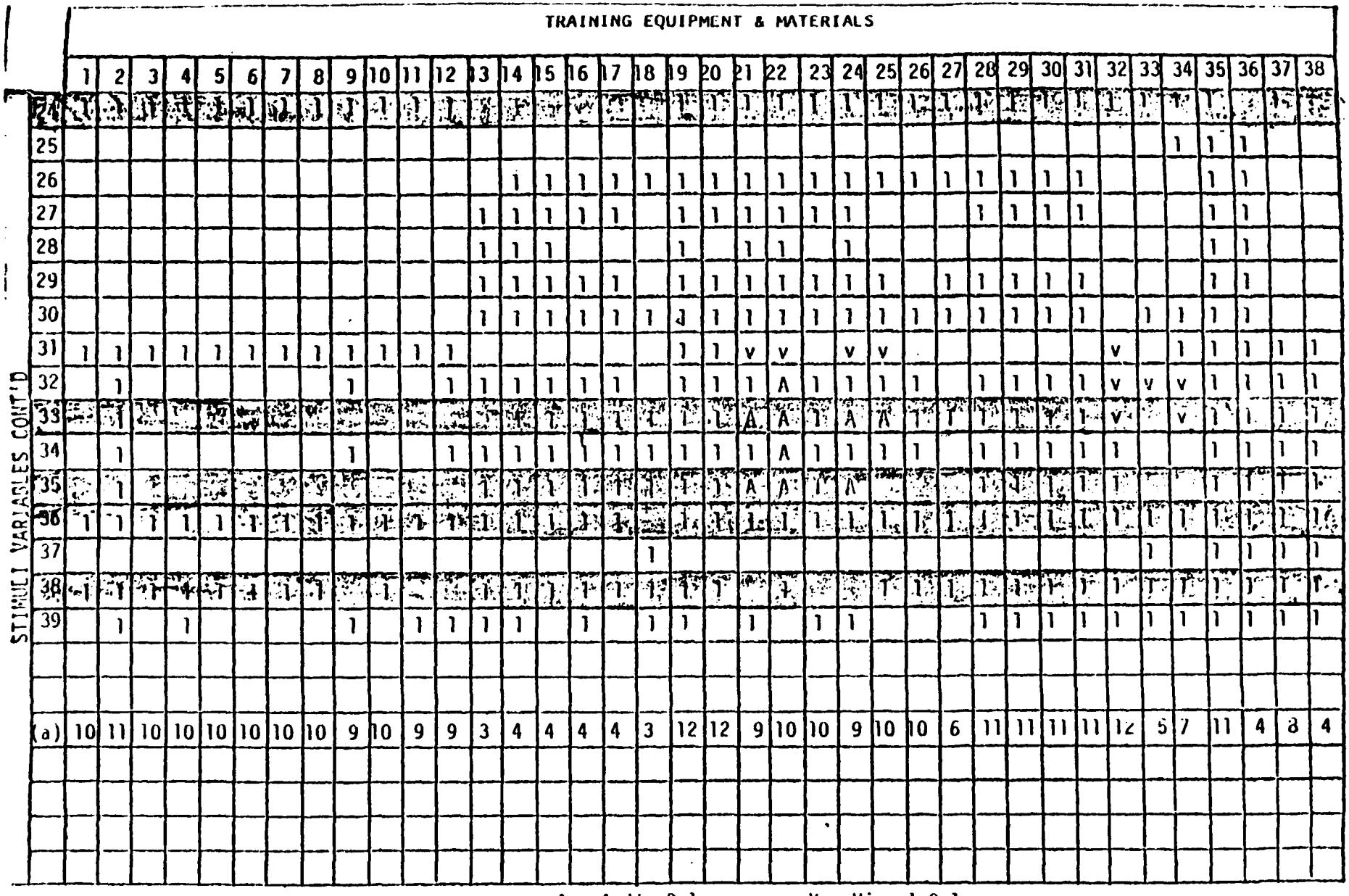

Figure III-5. Training Equipment and Materials Versus Stimuli Variables (continued)

of similar tasks). In this example, they were 1, 8, 9, 10, 14, 18, 22, 24, 33, 35, 36, and 38 (see paragraph b above). These rows have been shaded on Figure III-5 for convenience. The cells in these shaded rows are the only ones you are concerned with in this example.

(2) For each column, sum the cells of concern in which there is a "1." These sums are shown at (a) at the bottom of matrix. These sums reflect how well each device fits the conditions of the stimuli variables of the task.* The pieces of equipment showing the "best fit" are carrel (19), dial access information retrieval system - audio/visual (20), and computer (32). Because only a single task has been used in this example, more than one piece of equipment shows a "best fit." However, if more tasks had been used, the selection process would have narrowed down the number of "best fit" pieces of equipment. If there are a number of "best fit" pieces of equipment, however, the piece that costs the least would be the one selected. Complete descriptions of the three devices selected can be found in Appendix 5.

(3) Figure III-6 is the corresponding matrix for the response variables showing across the top the number of the 38 items of training equipment and materials versus the number of the 16 response variables in the left column. As with the stimulus variables, determine from Figure III-4, Coding Sheet, which of the numbered response variables you have decided are relevant to the task (or task grouping). In the example, these are 3, 6, 9, 12, 13, and 15 (see paragraph b above). These rows have been shaded on Figure III-6. The result of the summing of the appropriate cells is shown in row (b) at the bottom of the matrix.* The largest value in the row is 6, which corresponds to carrels (19), demonstrators (33), mock-up and panel (34), and operational equipment (35). The description for each device can again be found in Appendix 5.

(4) Finally, perform the same operations for the feedback variables. Figure III-7 is the matrix with the 39 items of training equipment and materials across the top and the 17 feedback variables in the left column. The feedback variables of interest (from Figure III-4, Coding Sheet) were determined to be 3, 10, 14, 15, and 16 (shaded in Figure III-7). The result of summing is shown in row (c) at the bottom of the matrix.* The "best fit" media are computer (32) and operational equipment (35).

(5) Now the method can be selected. Figure III-8 is a matrix with 23 methods across the top and 13 functional context variables in the left column. From Figure III-4, you have determined for this example that the functional context variables 3, 4, 5, 6, 9, 10, and 12 are relevant to this task. The results of summing the appropriate cells for the example are in row (d) at

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*If you can weight the difference in importance of the stimuli variables, then you must multiply each "1" in those cells of interest by your appropriate weighting before summing each column.

*Again, as for the stimulus variables matrix, if you can weight the importance of these response variables, you would multiply each applicable "1" by the corresponding weight.

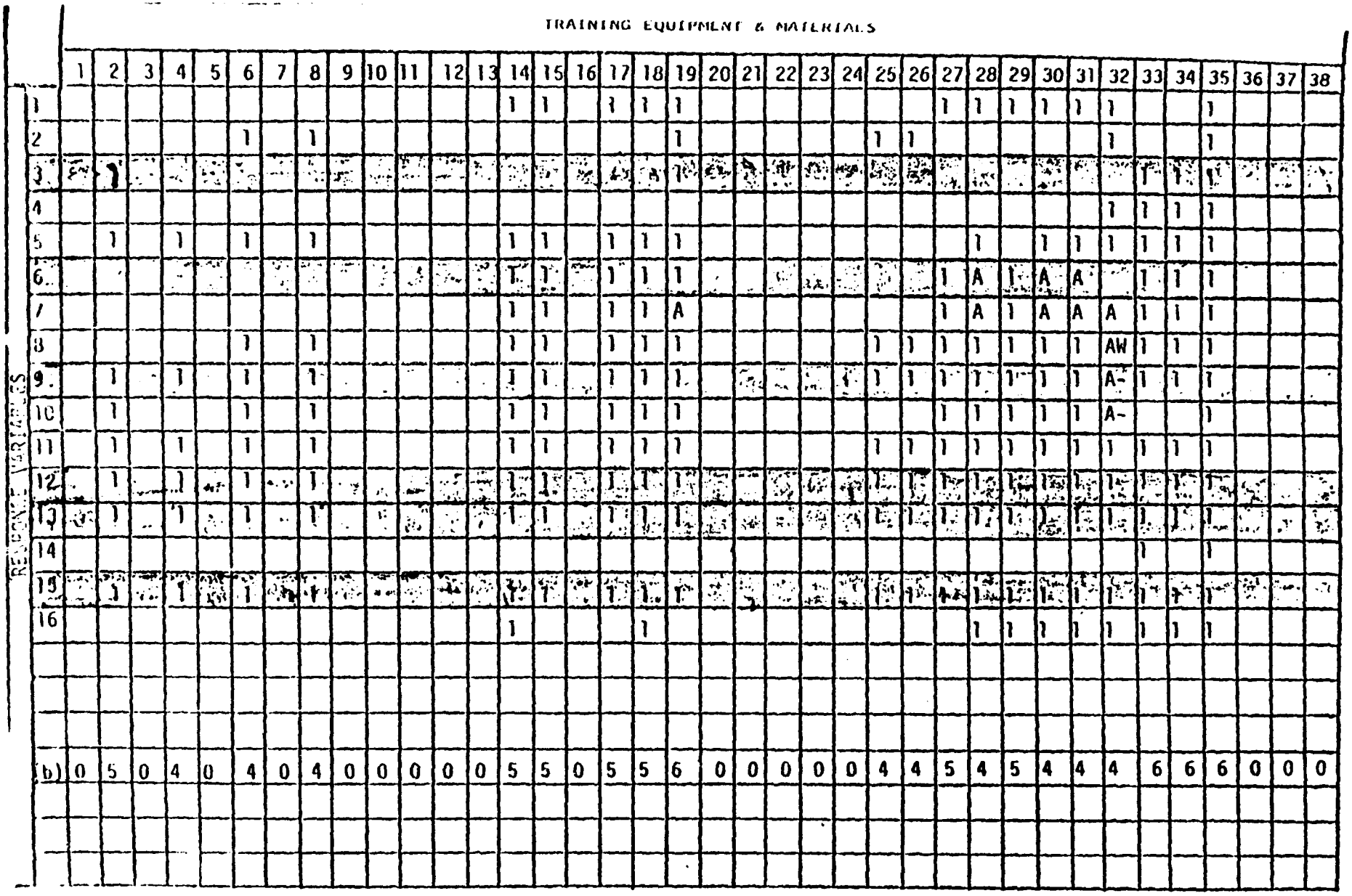

Figure III-6. Training Equipment and Materials Versus Response Variables

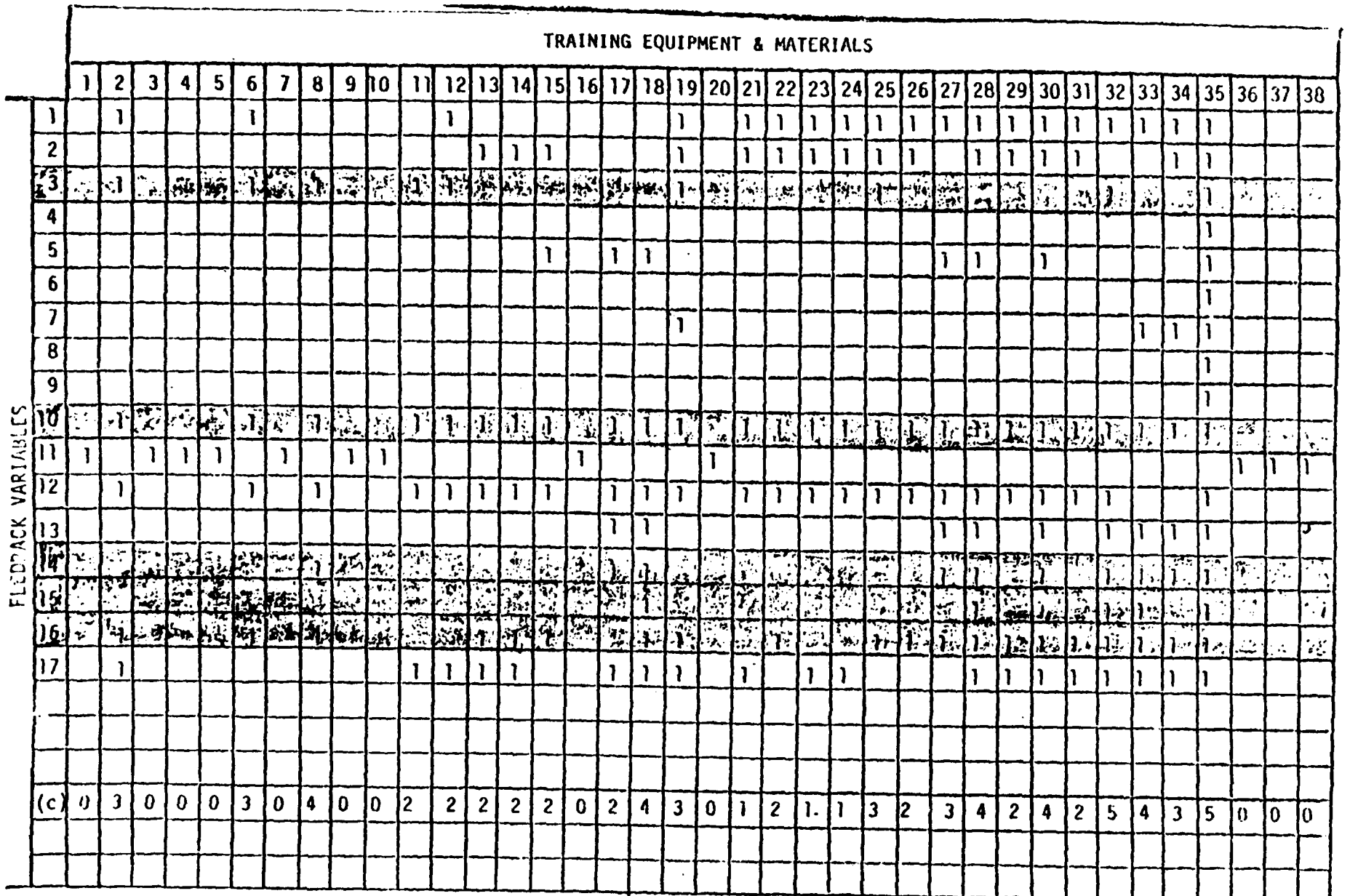

Figure III-3. Training Equipment and Materials Versus Feedback Variables

Functional Context Variables / METHOD		Lecture Standard	Lecture-Team Teach	Conference - Directed Discuss.	Conference - Seminar	Demonstration	Performance-Man. Ind. Practice	Performance-Man. Student Tutor	Performance-Man. Group Practice	Performance-Man. Group Contr. Prac.	Programmed Instruction	Study Assignment Individual Study	Study Assignment Supervised Study	Tutoring	Case Study	Incident Method	Role Playing	Sensitivity Training	Games	In-Basket Exercise	Brainstorming	Committees	Field Trips	Panels
Psychological Context	Low Impact																							
	High Impact			1										1								1		
Physical Context	Low Impact																							
	High Impact					1	1	1	1	1				1						1		1		
Stability of Function	Stable																							
	Unstable		1		1								1	1	1	1	1	1		1	1	1		
Function Performed in Role	Communicative			1				1	1	1				1	1	1	1	1				1	1	
	Perceptual																							
	Physical																							
	Mental																							
	Individual Performance																							
Role of Element	Team Performance			1	1			1	1	1					1	1			1					
	Supervisory																1	1		1				

(d) 5 4 3 2 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

the bottom of the matrix.* The method selected is tutoring (13). A description of each method is at Appendix 6.

g. For this example, the complete package would probably consist of a carrel for a stimulus presentation device, carrel for a response acceptance device, and a computer for a feedback evaluation device. The "best fit" method would be tutoring. If "instructor" had been included as a type of media in the selection matrices for media, the probability that an instructor would have been chosen over a computer for feedback evaluation is high, since he/she probably costs less and is much more flexible. In addition, an instructor would fit well with the tutorial method selected.

Only one task at a time has been considered in the selection of method and stimulus, response, and feedback equipment. If several tasks had been used, there would have been three vectors of sums for each media subprocess. Each one would have been grouped in a matrix and would have been subjected to the procedure that generates the efficiency ratios to be covered in paragraph C. A number of equipment choices would have thus been generated, but when a small number of related tasks is considered, the result is a single piece of equipment.

2. TECEP (Braby et al., A Technique for Choosing Cost-Effective Instructional Delivery Systems, TAEG Report No. 16, 1975)

Of all available analytical methods with potential applications to CTEA, this one appears to be the one most consistent with current ISD procedures (TRADOC Pamphlet 350-30). The ISD procedures, in Block III.1, employ the same learning guidelines and algorithms (for twelve types of training objectives) on which this method is based. The TAEG method is called Training Effectiveness, Cost Effectiveness Prediction technique (TECEP), and it is intended for use during the conceptual phase of training program development.*

The TECEP technique begins with a list of training objectives. If these are not available, they must be generated. Each training objective in the proposed training system is matched with the category of learning or learning algorithm of which twelve are given. These are reproduced in Table B-1-1 of Appendix 1 to Annex B with the characteristics of training objectives that can be accomplished with them.

a. Make a tentative classification by checking the learning objective against the information given for each category and decide in which it fits

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*See previous notes for stimulus and response variables regarding weighting. This is applicable here, also.

*The procedures herein have been taken from or adapted from:

a. Braby et al., Training Analysis and Evaluation Group, A Technique for Choosing Cost-Effective Instructional Delivery Systems, TAEG Report No. 16, Orlando, April 1975.

b. DA TRADOC Pamphlet 350-30, Interservice Procedures for Instructional Systems Development, Phase III, Develop, 1 August 1975 (much of which was adapted from TAEG manuscripts).

best. Compare the characteristics of the training objective with the action verbs, behavioral attributes, and examples of objectives as listed in the table.

If you have difficulty fitting a learning objective into a single category because it seems to fit equally well in several, the learning objective may not be specific or clear, the action required may be two or more objectives or it may have other faults. If creating two or more objectives is not feasible, decide what in the objective will require the most instruction. Place the objective in that category.

EXAMPLE

The learning objective might be "Paint barracks when painting is needed." Applying the paint is a repetitive mechanical skill, and the objective fits "performing gross motor skills." However, knowing when painting is needed requires choosing a course of action based on applying known rules, and the objective also fits "rule learning and using." Divide the original objective into two new ones: "Paint the barracks," and "Identify that barracks needs painting."

Group the training objectives into sets that are classified alike.

b. Appendix 2 to Annex B contains an Instructional Delivery System Chart for each category of learning or learning algorithm discussed in Appendix 1. For each group or set of training objectives:

(1) Select the Instructional Delivery System Chart corresponding to the learning algorithms of that set. The chart for the algorithm, Recalling Procedures and Positioning Movement, is provided as Figure III-9. Note that the columns headed Alternative Instructional Delivery Systems are divided into two sections; i.e., those permitting the full use of the algorithm and those not permitting full use. The latter group includes some existing or traditional practices that are considered to be less powerful or efficient than those enabling the full use of the algorithm. The analyst may wish to add additional approaches to either side of the chart.

(2) Each of the learning activities now must be translated into applicable stimulus criteria. The possible stimulus criteria are listed in the left column of the selection chart. If the activity involves sound alone, consider the choices under audio stimuli. If the activity involves visual stimuli, specify which visuals are needed. For each stimulus criteria applicable to the selected learning activities, put a check mark after the appropriate stimulus criteria on the worksheet. These are very important because they will be the basis for selecting the pool of media mixes. Required stimulus criteria are those basic qualities or capabilities of a medium (such as visual images, motion, color, and sound) that are required to carry out the intent of a learning activity. These required stimulus criteria can be specified by types of stimulus inherent in the learning activity, the student response, and performance feedback demands of the learning activity.

RECALLING PROCEDURES AND POSITIONING MOVEMENT

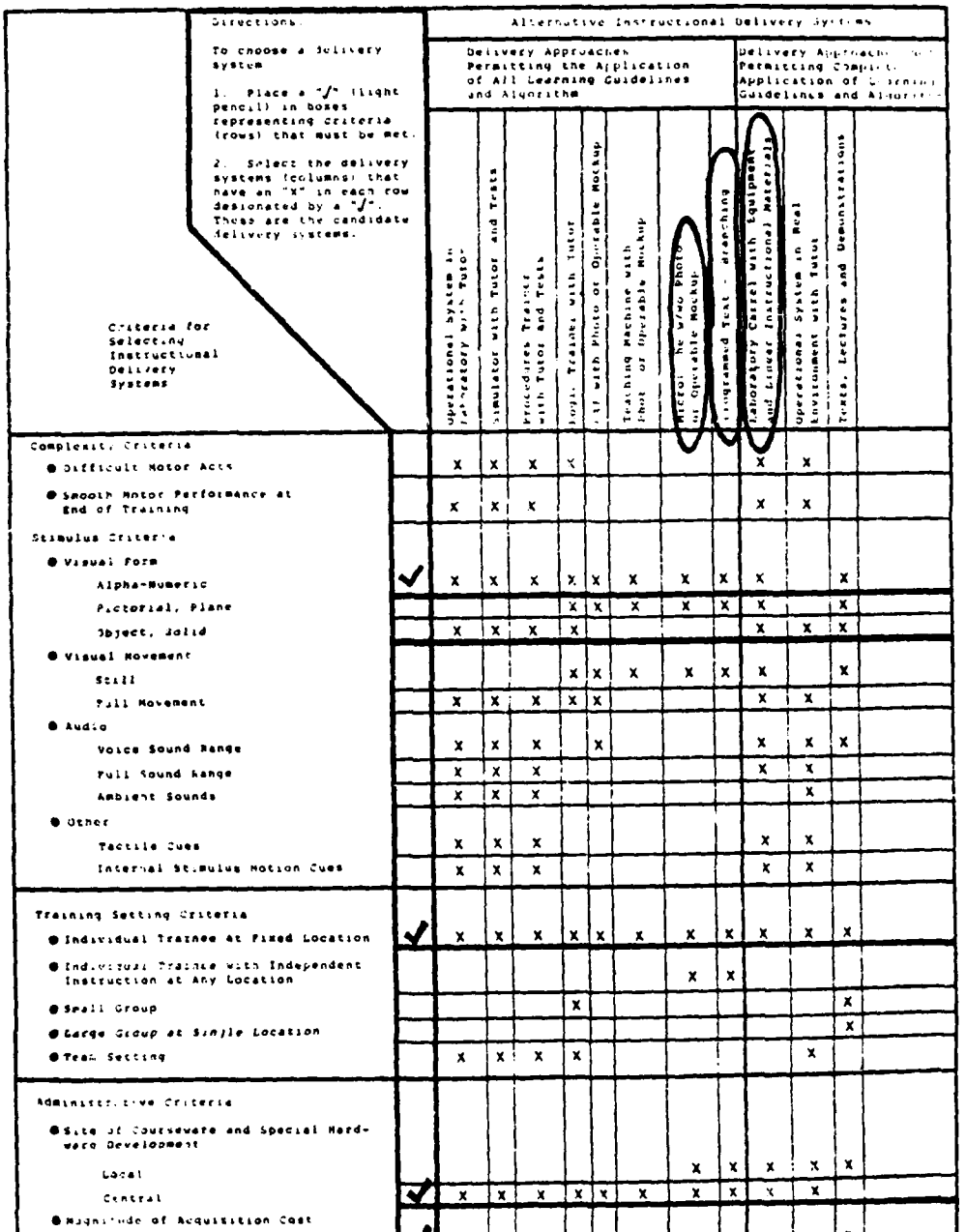

Figure III-9 Sample of Delivery System Selection

A media alternative is a form of instructional material that contains the stimulus criterion required by a specific learning activity. Identification of media alternatives is done by selecting those media within the learning category that meet the required stimulus criteria. These become candidates for possible use as part of the final delivery system.

(3) Along the left side of the chart also are listed requirements of the training setting, and certain administrative and budgetary constraints unique to the specific instructional program.

A blank column, with the heading "Directions" appears on the chart immediately to the right of the criteria list. To use the chart, place a light check in pencil in those cells designating criteria that must be satisfied by the delivery system. Then determine which delivery systems meet all these special criteria.

This part of the procedure has been carried out in Figure III-9. Note the criteria that were checked as being essential to the training program for this objective. Also note that only the circled delivery systems met all the special criteria. Two permit the full algorithm to be used, and one does not support the full use of the algorithm. The two tentatively recommended alternatives are:

(a) Microfiche with or without Photo or Operable Mock-up.

(b) Programmed Text-Branching

c. Each item remaining in the list of media should be evaluated in terms of the practicality of its use in the specific training system. Reject those media that are impractical. The media types that remain are considered to be candidates for use in the proposed system, and will be subjected to a cost analysis. Some of the factors that may be important in rejecting media types are:

(1) Marginal Technical Solutions: The learning guidelines cannot be easily carried out with the medium.

(2) State-of-the-Art: The basic medium is under development or test and may not be available for practical application by the time it is required.

(3) Size of System: Some media are useful within large training programs, others are suited only for small programs, and therefore may not be suited to the size program being considered.

(4) Interface with Existing Program: Many new courses must be designed to fit into existing programs, which places constraints on the new courses; e.g., equipment on hand, available classrooms, scheduling practices, etc.

(5) Time to Produce Media: Media which require long lead times for development may not be useful when scheduled ready-for-training dates do not allow a long development cycle.

(6) Budget Cycle Constraints: While the application of some of the powerful training approaches, such as CCTV (closed circuit television), may result in low costs per student graduate, the initial investment is substantial. Unless these resources appear in existing budgets, the application of these techniques to an immediate problem is not feasible.

(7) Adoption of Innovations: Project team members frequently resist innovations. If the proposed media is significantly different from existing techniques, either adequate resources must be focused upon gaining acceptance for the innovation, or a more traditional approach must be selected.

(8) Courseware Development: If the courseware is to be locally developed, skilled personnel, equipment, time, and dollars must be available.

(9) High Cost Alternatives: The projected life cycle cost of a media approach may be significantly higher than other equally useful alternatives. Reject high cost alternatives.

(10) Learning Style of Trainees: If trainee has low reading ability or would be limited in his ability to use certain kinds of media, then reject these media as inappropriate.

(11) Other Constraints: A variety of other practical factors should be considered; e.g., command policy and existing investment in production facilities.

In the case of the sample problem (Figure III-9), the approach requiring the use of programmed text-branching is found to be a practical solution with some risk associated with "learning style of trainees". No other problems were identified by considering each criterion in the practicality test. During consideration of the microfiche-based approach, however, a low degree of risk was identified for two items. The first low risk area concerned test item Number 2, the "state-of-the-art." Studies involving the use of color microfiche in procedure-following training have not been conducted within the Department of Defense. However, applications in industry have been successful. Some risk, however, is associated with the initial applications of colored microfiche in the military environment. The second low risk area concerned test item Number 8, "courseware development." It is assumed that the team developing courseware will have no experience in developing microfiche-based courseware. This lack of experience is not considered to be a serious problem. Skills required would be similar to those used in writing programmed texts and making slide sets. The reproduction of the color microfiche would be accomplished by a commercial laboratory.

Both instructional delivery systems survived the practicality test and are considered to be candidates for use in the proposed training system.

3. DIVAD Gun

Given a "generic" task list as generated in paragraph A1 above (page III-1), you must again rely on your subject matter expertise and good judgment or find an SME to help you develop training alternatives. For example, in the DIVAD Gun CTEA, the analyst was an SME and had some familiarity with the DIVAD

Gun and training device configurations and capabilities. He formulated the following three alternatives:

a. Training conducted with operational equipment only.

b. Training conducted with reduced operational equipment augmented by the classroom trainer.

c. Training conducted with further reduced operational equipment augmented by both the classroom trainer and the maintenance trainer.

As with the generation of the "generic" task list, this method is a last resort when "something is better than nothing" and is based totally on previous experience.

4. Analogous Task Method

Having generated a task list by any of the methods in A above (see pages III-1 to III-6), you must now locate a training yardstick against which a proposed training plan can be evaluated. The yardstick should provide you with the ability to predict the level of success of the training plan, to diagnose those parts likely to be problematic, and to prescribe alternative components for these parts. Since training will be given on a task by task basis, the yardstick must be in reality many yardsticks, one for each task. To fulfill the three purposes of prediction, diagnosis, and prescription, detailed training information is required.

One likely source of such information is the training being done for tasks on fielded systems. The training on a fielded system has usually been used, tested, and modified. It can therefore serve as a working model of training for the system in development and as a source of evaluative data on the effectiveness of training. The central difficulty in using this training information is the necessity to decide which task on one or more fielded systems most closely approximates the task whose training is being predicted. The problem is two-fold. First, you must define the criteria by which you will decide whether a fielded task is similar or analogous. Second you must locate analogous tasks. Remember that your concern, especially in the early stages of development, should be focused on the form of training (the training approach, the training resources needed, etc.) rather than the content of training. Tasks which are sufficiently different so that the content of the training is of little use may still provide valuable information about the appropriate form of training.

a. Task Classification

(1) Classify the target task by:

- the action verb in the task description,
- the body of knowledge the soldier must understand as general background to task performance,
- the stimuli provided by the equipment (or external source) to initiate the task,

- the response made to the stimuli,

- the feedback provided to indicate proper or improper performance of the task.

(2) Determine the task type by the action verb and the knowledge context for each task. The knowledge or task context is the general nature of the equipment and the action performed with it. For some tasks, the context will be explicit in the task verb. For example, "Fly" is a task performed with aircraft (or missiles). For other tasks, the action occurs in a variety of contexts. Therefore, you must derive the context from the task description as a whole. "Troubleshoot," for example, is an action performed with electrical, electronic, automotive, and mechanical equipment, among others. The subtasks and task elements of "Troubleshoot" in these various contexts will be very different. Not all tasks have a specific context. You may find tasks for which a context is not important. That is, the task requires the same action regardless of the nature of the equipment on which it is performed.

The types of actions fall into 15 major categories:

- 1. Selecting and using roles
- 2. Making decisions
- 3. Solving problems
- 4. Monitoring
- 5. Classifying perceptual, non-graphic signals
- 6. Identifying graphic symbols[1]
- 7. Communicating by voice[2]
- 8. Communicating by writing or typing[2]
- 9. Communicating non-verbally (signaling)[2]
- 10. Following procedures
- 11. Positioning movements
- 12. Discrete regulatory movements
- 13. Continuous regulatory movements
- 14. Performing complex skills
- 15. Gross motor movement

Compare the action verb with those in the task verb list (Appendix 1 of Annex C). The list gives the task type to which each verb meaning has been assigned. If the verb does not appear in the task verb list, compare the verb with the descriptions and examples of each type that appear in

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[1]Many action verbs indicating the process of classifying are independent of the object classified. These verbs are appropriate for both categories 5 and 6. To classify a particular task when these verbs are used, you must also determine the nature of the classified object.

[2]Many action verbs indicate the process of information transfer without reference to the means of transfer. These verbs are appropriate to both categories 7 and 8. These verbs may also be appropriate to category 9 although signaling is not usually appropriate to the communication of large quantities of information or fine detail. To classify a particular task when these verbs are used, you must also determine the communication process.

the synonym list (Appendix 2 to Annex C). The verb may be an unlisted synonym for one of the verbs in the synonym list. If not, assign the verb to that category which most closely describes it.

(3) Determine the type of initiating cue or stimulus. The initiating cue which indicates that a task should begin can be classified as visual, auditory, tactile, body motion, limb motion, olfactory, or gustatory. These are defined in Table III-1. The characteristics of the cue can be classified along several dimensions. Some of these dimensions are general. That is, cues in all of the categories can be classified along these dimensions. The dimensions, defined in Table III-2 are the likelihood that the cue will occur during a mission, the rate at which the cue will occur, the intensity or contrast of the cue with respect to the background, and the presence of other cues competing for attention. In addition, there are dimensions specific to cues in the visual and auditory categories. Visual cues are classified by their form, movement, and color; auditory cues, by their pattern, range, and pitch. The visual dimensions are defined in Table III-3 and the auditory dimensions, in Table III-4.

The initiating cue for a task may have components in more than one category. However, each component will have only <u>one</u> characteristic value along each of the dimensions. For example, the cue may have visual (1) and tactile (3) components. The tactile component may be likely to occur (0.1.2), but only once (0.2.1), it may be high in contrast (0.3.2) and occur when other cues do not (0.4.1). The visual component may be low in contrast (0.3.1) with the other three characteristics the same as for the tactile component. In addition, the visual component may be alphanumeric (1.5.2), still (1.6.1), and black and white (1.7.1). Note that the visual component can be low in contrast while the tactile component is high, but the visual component cannot be both low and high in contrast itself.

(4) Determine the type of response to the stimulus. The response completing the task can be classified as verbal, written, manipulative or exertive (see Table III-5). The responses in all categories can be assessed as to the pattern and required rate of response, the effort necessary to make the response, the presence of competing responses, and the allowable flexibility of response. The specific values distinguished along these dimensions are defined in Table III-6. As with the cues, the responses can have components in more than one category but each component will have only <u>one</u> characteristic value along each of the dimensions.

Note that to classify a response as exertive does not mean that the amount of effort expended is high nor must a manipulative action be low in effort. Pushing a cart (exertive), for example, may require little effort while positioning a lever (manipulative) may require much effort. You may have difficulty classifying responses in which a force is applied to position an object. It may be helpful to focus on the basic nature of the response. If the response is concerned with movement, then the response is exertive; if the response is concerned with final position and the movement is secondary, then the response is manipulative.

TABLE III-1

Categories of Initiating Cues

1. Visual cues - signals received through the sense of sight.

2. Auditory cues - signals received through the sense of hearing.

3. Tactile cues - signals received through the sense of touch, including cues from the texture, size, or shape of an object and from vibration on the skin.

4. Body Motion cues - signals received through sense of equilibrium, including cues from external forces that cause the body to roll, pitch, yaw, heave, sway and/or surge.

5. Limb Motion cues - signals received through the proprioceptive sense, such as are felt when the arms, legs, fingers, etc., are moved.

6. Olfactory cues - signals received through the sense of smell.

7. Gustatory cues - signals received through the sense of taste.

TABLE III-2

General Dimensions of Cue Characteristics

0.1	Cue Likelihood	
0.1.1	Unlikely	Cue is not expected by the operator or maintenance personnel because of low likelihood or irregular pattern of occurrence.
0.1.2	Likely	Cue is expected by the operator or maintenance personnel because of previously occurring cues or a regular, cyclical occurrence of the same cue.
0.2	Cue Occurrence Rate	
0.2.1	Single	A single cue occurs in the course of a mission (assuming that a cue does occur).
0.2.2	Low Rate	A slow or low rate of occurrence of the cues through the course of the mission.
0.2.3	High Rate	A fast or high rate of occurrence of the cues through the course of the mission.
0.3	Cue Intensity or Contrast	
0.3.1	Low	Cue is of low intensity and low contrast, i.e., a signal which blends into the background noise of that sense and is therefore difficult to distinguish or detect.
0.3.2	High	Cue is of high intensity or a cue of high contrast, i.e., a signal which stands out from the background by reason of higher or lower intensity, and is therefore easy to distinguish.
0.4	Cue Competition	
0.4.1	Low	Cue occurs when few other cues or actions are competing for the attention of the operator or maintenance personnel.
0.4.2	High	Cue occurs when other cues or actions have the attention of the operator or maintenance personnel and therefore the cue may be missed or reaction to the cue may be delayed.

TABLE III-3

Dimensions of Visual Cue Characteristics

1.5	Visual Form	
1.5.1	Spot	Unitary dots or flashes of light (dots in the context of grids or other lines should be classified as visual graphic - 1.5.4).
1.5.2	Alphanumeric	Words and/or numbers presented visually.
1.5.3	Symbolic	Symbols such as graphic characters not in text.
1.5.4	Graphic	Two-dimensional schematic images, such as maps, graphs, and mathematical curves.
1.5.5	Pictorial	Two-dimensional images, such as television pictures, photographs, and drawings.
1.5.6	Solid Object	Three-dimensional images or objects.
1.5.7	Ambient Light	Changes in the general illumination level in an enclosure or the environment.
1.6	Visual Movement	
1.6.1	Still	Static visual images such as still photographs, drawings, or printed pages.
1.6.2	Limited Movement	Partially static visual images with elements that move over a limited portion of the image.
1.6.3	Cyclic Movement	Visual images in which the elements move over the full extent of the image but in a fixed, repetitive sequence.
1.6.4	Full Movement	Visual images in which all elements move over the full extent of the image without restriction.
1.7	Visual Color	
1.7.1	Black and White	Visual images composed of black and white elements, such as printed pages or line drawings (images with dichotomous colors such as brown and beige printed pages or green and black CRT displays are classified as black and white).
1.7.2	Half Tone	Visual images composed of black, white, and various gradations of gray such as black and white photographs and black and white television pictures.
1.7.3	Color	Visual images composed of several (more than two) colors such as color television pictures or color motion pictures.

TABLE III-4

Dimensions of Auditory Cue Characteristics

2.5	Auditory Pattern	
2.5.1	Steady	Sounds or noises which do not vary in pitch.
2.5.2	Quavering	Sounds or noises which alternate rapidly between two pitches.
2.5.3	Patterned	Sounds or noises which change pitch in a cyclic or patterned way such as a melody.
2.5.4	Irregular	Sounds or noises which change pitch in an irregular or random way.
2.5.5	Ambient Sound	Changes in the mixture of sounds and noises which form the auditory background in an enclosure or in the environment.
2.6	Auditory Range	
2.6.1	Limited Range	Sounds or noises limited to a small number of pitches.
2.6.2	Voice Range	Sounds in the form of words in the normal range of the spoken voice.
2.6.3	Full Range	Sounds or noises which vary over all or most of the audible range.
2.7	Auditory Pitch	
2.7.1	Low	Sounds or noises with a low pitch (frequency).
2.7.2	High	Sounds or noises with a high pitch (frequency).

TABLE III-5

Categories of Responses

1. Verbal responses - responses delivered in an audible spoken message, with words from a small, stylized set or freely chosen.

2. Written responses - responses delivered in a written message, with words from a small, stylized set or freely chosen, or by checking a previously written response on a form.

3. Manipulative responses - responses delivered by positioning dials, controls, switches, keys, levers, or wheels, or positioning of hand-held tools.

4. Exertive responses - responses delivered by the application of force to an object or tool with the hand, foot, or body.

TABLE III-6

Dimensions of Response Characteristics

0.1	Response Pattern	
0.1.1	Single Action	A single action is necessary to accomplish the task.
0.1.2	Repeated Action	A single action performed repeatedly is necessary to accomplish the task.
0.1.3	Non-Ordered Action	A fixed set of actions is necessary to accomplish the task but the order of performance is not important.
0.1.4	Procedure	A fixed set of actions performed in a specified order is necessary to accomplish the task.
0.1.5	Continuous Regulation	A variable set of actions is necessary to continuously maintain control or guide a changing system such as to steer an automobile.
0.2	Required Rate of Response	
0.2.1	Slow Rate	For a single action (0.1.1), the time between cue and response may be long, i.e., the response need not be immediate. For a series of actions (0.1.2-0.1.5), the rate at which successive actions are performed may be slow.
0.2.2	Fast Rate	For a single action (0.1.1), the time between cue and response must be short, i.e., the response must be immediate. For a series of actions (0.1.2-0.1.5), the rate at which successive actions are performed must be rapid.
0.3	Required Response Effort	
0.3.1	Low	The effort required to perform the response is small.
0.3.2	High	The effort required to perform the response is large.
0.4	Response Competition	
0.4.1	Low	Response is made when few other actions or cues are competing for the attention of the operator or maintenance personnel.
0.4.2	High	Response is made when other responses or cues are competing for the attention of the operator or maintenance personnel.
0.5	Response Flexibility	
0.5.1	None	Only a specific response or set of responses can accomplish the task.
0.5.2	Some	Any of a number of responses or sets of responses will accomplish the task.

Note also that the task category does not necessarily imply the response category. Performing gross motor skills (15) and communicating by voice (7) are likely to have responses in the exertive (4) and verbal (1) response categories respectively. However, steering and guiding (13) tasks may require responses in either the manipulative (3) or exertive (4) category while responses for procedural (16) tasks may be in any of the response categories. Perceptual and mental tasks (1-6) may also require responses in any of the response categories.

(5) Classifying the feedback which indicates response accuracy and task completion is also an essential component of task classifications. The categories of feedback are visual, written, auditory, verbal, tactile, kinesthetic, olfactory, and gustatory. The categories, defined in Table III-7, are quite similar to the categories of initiating cues. They differ on two points. First, the importance of language use in feedback is recognized by distinguishing classes of visual and auditory feedback (written and verbal, respectively) which are exclusively based on language and making them separate categories. Second, the distinction between body motion and limb motion is less important in feedback and they have been grouped into a single, kinesthetic category. Feedback in all categories should be judged as to information content, source, and timing. The values to be distinguished along these three dimensions are defined in Table III.8.

It may be tempting to end the search for analogous tasks as soon as the first minimally acceptable one is located. Remember that the accuracy of the training estimates (derived from the analogous tasks) is directly related to the similarity of the tasks. Therefore it is clearly advantageous to continue the search for an analogous task until a close match is identified. This is not to say that an open ended search for the "perfect" match must continue. A middle ground approach, however, will pay dividends.

In comparing multiple analogous tasks apply the remaining criteria in the order given. That is, first compare the specific task verbs. Only if the task verbs are the same should you apply the next criterion, stimulus type. You should consider any synonyms identified directly in the Category/Synonym List in Appendix 2, as equivalent to identical task verbs. As with the response, correspondence on stimulus means agreement both as to category and value of characteristics on the dimensions analyzed. As above, only if the tasks correspond on stimulus should you consider the specific response, and necessary conditions, and feedback.

Table III-9 is a hypothetical example of the application of the Analogous Task Method for the prediction of training programs. It compares the target task, Track on Aerial Target with two candidate analogous tasks of tracking aerial targets. In this case, you can see there is complete correspondence until you come to feedback (Table III-7). This indicates that you may want to retain both candidates in order to have alternative training programs. The training program for analogous task number 2 may be more effective than number 1 when it is modified to compensate for the feedback variation.

TABLE III-7

Categories of Feedback Information

1. Visual feedback - information presented through the sense of sight with the exception of written messages and texts.

2. Written feedback - information presented through the sense of sight by means of words and/or numbers, written, printed, or displayed in the form of a message or text.

3. Auditory feedback - information presented through the sense of hearing with the exception of spoken messages and texts.

4. Verbal feedback - information presented through the sense of hearing by means of words spoken directly or transmitted by communications equipment.

5. Tactile feedback - information presented through the sense of touch, including information about the texture, size, or shape of an object and vibrations on the skin.

6. Kinesthetic feedback - information presented by means of body or limb motion either through the sense of equilibrium or the proprioceptive sense.

7. Olfactory feedback - information presented through the sense of smell.

8. Gustatory feedback - information presented through the sense of taste.

TABLE III-8

Dimensions of Feedback Characteristics

0.1	Feedback Information Content	
0.1.1	None	No feedback given.
0.1.2	Response Execution	Feedback indicates whether or not a response was made and registered by the equipment but does not indicate whether or not the response was correct.
0.1.3	System Status	Feedback indicates the general status of the system and/or its environment. Changes in system status from previous reports may reflect the consequences of the response made and/or independent changes in the system (environment). If the effect of the correct response on the system (environment) is known, the correctness of the response may be <u>inferred</u> from the status report.
0.1.4	Response Execution/ System Status	Feedback indicates both the status of the system and/or its environment <u>and</u> the performance of a response.
0.1.5	Response Correctness	Feedback indicates directly whether or not a response was correct. Feedback about response correctness confirms that a response was made and makes system status information superfluous as feedback.
0.2	Feedback Source	
0.2.1	Intrinsic	Feedback is provided automatically by the system or is obvious from the effect of the response on the system or its environment.
0.2.2	Extrinsic	Feedback that is provided by the system only when requested by the operator or maintenance personnel.
0.3	Feedback Timing	
0.3.1	Immediate	Feedback is delivered immediately following the response.
0.3.2	Delayed	Feedback is delivered at some prolonged interval after the response.

TABLE III-9

TARGET TASK: Track an Aerial Target

Table	Target Task	Analogous Task #1	Analogous Task #2
Action Verb	Track	Track	Track
Verb Category (p. III-32)	13	13	13
III-1	1 + 2	1 + 2	1 + 2
III-2	0.1.2 0.2.3 0.3.1 0.4.2	0.1.2 0.2.3 0.3.1 0.4.2	0.1.2 0.2.3 0.3.1 0.4.2
III-3	1.5.1 1.6.2 1.7.1	1.5.1 1.6.2 1.7.1	1.5.1 1.6.2 1.7.1
III-4	2.5.1 2.6.1 2.7.2	2.5.1 2.6.2 2.7.2	2.5.1 2.6.1 2.7.2
III-5	3	3	3
III-6	0.1.5 0.2.2 0.3.1 0.5.1	0.1.5 0.2.2 0.3.1 0.5.1	0.1.5 0.2.2 0.3.1 0.5.1
III-7	1	1	3
III-8	0.1.4 0.2.1 0.3.1	0.1.4 0.2.1 0.3.1	0.1.4 0.2.1 0.3.1

b. Training Assessment

If two analogous tasks correspond with the task in development on all the criteria, then the training information from the two tasks should be considered jointly. However, one final criterion should be considered first: the population of soldiers who will be performing the task. You should determine the experience level (defined as pay grade) of the soldiers who will be operating and maintaining the new weapons system and identify which analogous task is performed by soldiers with the most comparable experience level. If the analogous tasks correspond here too, then consider both tasks together.

For each analogous task identified, obtain the details of training. These details will be in the Course of Instruction (COI) or lesson plans and the specifications for training devices used in the training. The training on the analogous task can be used as the training plan for the target task if no plan has been formulated. If there is a training plan, then differences between the training plan and analogous task training will indicate potential difficulties in training to be watched for in operational testing.

C. Estimation of Effectiveness

1. TEEM

TEEM, for the present at least, determines effectiveness by manually recording the trade-offs made during the generation of an estimated training program. A computer program is being developed to accelerate this process. You can then use these to determine the potential decision cost loss for the chosen training program against an ideal program with no constraints. Although such a measure supplies no information about the absolute value of a number so generated, it does provide a standard of comparison for several training programs generated using the same CTEA method. This has potential advantages not only for the comparison of alternative programs for a given weapon system, but also between systems.

In the TEEM model, this measure is referred to as the efficiency ratio. It represents a value which is composed of the efficiency score of an estimated program with real world constraints, divided by the efficiency score of an idealized program, which is subject to no constraints. The actual value is generated in the following manner.

a. Record the selection matrix scores from Section IIIB1 (Figures III-5, 6, and 7) for each media matrix and each task. (See Figures III-10a, 10b, and 10c). This produces three matrices of summed values, where the rows correspond to tasks and the columns correspond to the degree of fit which that task had to each of the potential training media for each stimulus, response, and feedback function. Figure III-10 shows such matrices completed only with the numbers generated in our example (Section IIIB1). If the largest sum in each row is chosen initially for devices, a large number of different equipment choices is produced, spread over all the tasks which are being considered in that functional group. Thus, for a sample group of six tasks there might be six different media choices for each of the three media functions or a total of 18 different devices. If cost were no object, and there were no resource or time constraints, the ideal choice of media would be all 18 pieces. The total of the equipment fit scores for those 18 pieces would then represent a score of an ideal choice without constraints. This, of course, is not realistic, since there are always constraints that enter into any decision. As these constraints are applied, the viability of a particular piece of equipment for a particular task may change. For example, even though it may not be an optimal choice, you may have on hand a particular training device and want to include that equipment in the program, rather than buy a new one. The particular piece of equipment may permit combining several tasks, rather than individually training each. In the above example, this corresponds to choosing one of the other sums in the task row, which relates to the particular piece of equipment you desire to use. If you were to do this for all six tasks, i.e., force the choice of a single piece of equipment, the sum of the numbers corresponding to that piece of equipment would be lower. Thus, the efficiency of that particular decision would be lower than the ideal case, as would all other potential combinations. If this value is then divided by the ideal first value, what would be produced is a ratio of actual to ideal, or in the terminology used above, an efficiency ratio.

b. After you have recorded in the three matrices (Figure III-10) the selection scores for each task, select the largest value entered for that task

(a) STIMULUS

TASK NUMBER \ MEDIA NUMBER	19	20	32	•	•	Mn
1	12	12	12			
2						
•						
•						
Tn						
TOTAL						

(b) RESPONSE

TASK NUMBER \ MEDIA NUMBER	19	33	34	35	•	Mn
1	6	6	6	6		
2						
•						
•						
Tn						
TOTAL						

(c) FEEDBACK

TASK NUMBER \ MEDIA NUMBER	32	35	•	•	•	Mn
1	5	5				
2						
•						
•						
Tn						
TOTAL						

Figure III-10. Overall Measure Matrices

in each matrix. Add these largest values for each task in each matrix. This produces three sums for each matrix: $S_{stimulus}$, $S_{response}$, and $S_{feedback}$.

c. Add the three S values together for a measure of the overall fit of the media combination chosen for all tasks and all functions.

$$\text{Overall Measure} = S_{stimulus} + S_{response} + S_{feedback}$$

d. Record the overall measure. Sum each column of each matrix. Repeat the above procedure, after removing the media in each stimulus, response, and feedback matrix having the lowest column sum across all tasks. Record this new overall measure and repeat until all media have been considered.

e. Plot the ratios of the overall measure values, using the first value as the denominator for all the remaining values.

$$\text{Ratio 1} = \frac{\text{First Overall Measure}}{\text{First Overall Measure}} = 1$$

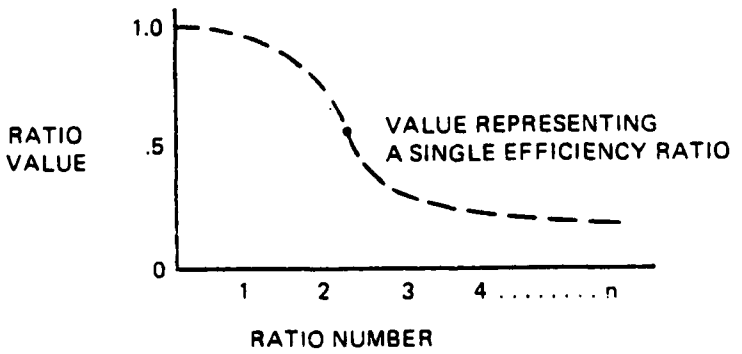
$$\text{Ratio 2} = \frac{\text{Second Overall Measure}}{\text{First Overall Measure}} = \text{Some Value} < 1$$

o

o

o

$$\text{Ratio n} = \frac{\text{Last Possible Overall Measure}}{\text{First Overall Measure}} = \text{Some Value} << 1$$



2. DIVAD Gun

Given "generic" tasks as developed in paragraph A.1. (page III-1) and training alternatives as developed in paragraph B.3 (page III-20), you must again use your judgment and your subject matter expertise or someone else's. You probably will have no measures of effectiveness, but may still be able to rank order the alternatives as to expected effectiveness. For example, the analyst in the DIVAD Gun CTEA formulated these three training alternatives (see paragraph B.3, page III-20).

a. Training conducted with operational equipment only.

b. Training conducted with reduced operational equipment augmented by the classroom trainer.

c. Training conducted with further reduced operational equipment augmented by both the classroom trainer and the maintenance trainer.

The first alternative was judged not likely to be effective because of its relative inflexibility in presenting a variety of battlefield scenarios to the student; the other two alternatives, because of the presence of the classroom trainer, offered this capability. Of the other two alternatives, alternative c was judged most likely to be the more effective because of the presence of the maintenance trainer.

As with the generation of tasks and training alternatives, this method is largely intuitive and judgmental. As such, you would not use it unless you had nothing else.

3. Analogous Task Method

Having developed a training program by the analogous task method (see paragraph B.4. above), obtain performance information to be used as a measure of effectiveness of the training. The measure is defined as the proportion of soldiers achieving criterion performance on the task following training. If data from the hands-on portion of the Skill Qualification Test (SQT) are available for that task, then use them to calculate effectiveness. If not, use the written portion in their place. Where no SQT data are available, use data from an end-of-course test. In the absence of all formal assessment tests, ask the instructor to estimate the proportion of soldiers who learn the task.

If the Course of Instruction (COI) for the target task is identical to that of the analogous task, use the effectiveness measure for the analogous task as the estimate of effectiveness for target task.

If the COI differ, use the effectiveness data from SQT or end-of-course tests as a criterion against which you compare the proposed effectiveness. Ensure that the criterion dimensions for the two are the same. If you have identified more than one analogous task, combine the data in the following manner. If the COI and/or lesson plans are roughly the same, average the effectiveness measures to obtain the estimate of effectiveness for the target task. If the COI differ among the analogous tasks, select that with the highest effectiveness measure.

As data on training are obtained from OT I and OT II, substitute the direct estimates for performance on the task for the measures based on analogous tasks.

Since training for different tasks may develop at different rates or you may find analogous tasks for only some of the critical tasks, it is entirely possible that some of the tasks will have only analytical measures while others have performance measures. Therefore, combining measures into a single aggregate effectiveness measure will not be meaningful. Even if all measures are performance measures, a reasonable set of weights for combining the measures may be difficult to deduce. In both cases, a verbal rather than numerical overview of training is suggested.

4. TRAINVICE, PM TRADE, Training Device Requirements Document Guide: A Procedures Handbook for Directorate of Training Development Project Offices for Devices, 1979.

If it is known that a simulator or other major training device is planned or considered for a weapon system, the CTEA analyst may need to estimate the effectiveness of the devices as part of the overall training effectiveness prediction. (Please note, however, that if a major device has been identified as required, procedures specify a separate LCSMM approach with a COEA, CTEA, etc., specific to its development.) An excellent method for you to use for this is TRAINVICE. Five separate analyses are required. These are:

- o Task commonality analysis
- o Physical similarity analysis
- o Functional similarity analysis
- o Learning deficit analysis
- o Training technique assessment

Information on similar devices already in the Army inventory may be helpful and may be obtained by contacting the Army Training Support Center (ATSC), Ft. Eustis. This group has access to information on all Army training devices now produced or being developed. They will need from you all the data available so far concerning the task(s), skill and knowledge, and operational effectiveness objectives. If you have identified training media characteristics, they should receive these data also.

The action officer at ATSC can then determine if training devices in the inventory have characteristics that match. An exact match on all characteristics is unlikely but some currently inventoried devices may have several in common with your requirements. For each device ATSC should send you a list of tasks it is designed to train. For tasks that correspond to task training requirements, additional information that gives a list of task elements (or subtasks) for each task and a list of controls and displays involved in the performance of each task may also be provided. If no existing device data are available, theoretical device concepts may be substituted. A hypothetical 'ideal' device would be a perfect match on all variables and you may modify as seems advisable to match known constraints of time, equipment, etc.

To analyze alternative device effectiveness you may proceed as in the following example.* Suppose you are comparing three alternative proposed training devices. We will assume for this example that devices A, B, and C are proposed; that devices similar to A and B exist; and C is as yet only a concept. Two known task training requirements are Task 1, Fire main gun using primary sight (M-32); and Task 2, Adjust fire using Burst on Target (M-32 sight). These tasks and their subtasks may be listed as shown in Table III-10. Next you will perform the five analyses. Task Commonality is first.

a. Task Commonality. For each task to be trained on each training device you will derive a task commonality index. Using a table as shown in Figure III-11, proceed as follows:

(1) List the task elements down the left column of Figure III-11.

(2) List the training devices or concepts to be assessed across the top of the table.

(3) For each device or device concept under consideration list on a separate piece of paper the elements of the task as they would be trained on that device.

(4) For each task element in the left column of Figure III-11 determine whether a device enables the trainee to practice that task element by examining the separate list of task elements for that device.

(5) If the training device does allow practice of that operational task element, then enter a "1" in the appropriate cell for that device.

(6) If the particular task element is not represented in the training device, either because the task is truncated or simplified, then enter a "0" in the appropriate cell.

(7) Repeat this procedure for each task element of the training task.

(8) Repeat the entire procedure for each training device or device concept under consideration.

(9) For each training device or device concept under consideration, total the number of "1's" (i.e., the number of task elements for which the training device allows the trainee to actually practice the training task).

(10) Enter the total number of "1's" for each device in Figure III-11.

(11) Derive the task commonality index value by dividing the total number of "1's" by the total number of task elements in the training task plus the total number of task elements unique to a device which are not related to the training requirements. The number of elements unique to a device and not

*The source of the illustrative example is the referenced document, PM TRADE (1979).

Table III-10. Example Task Training Requirements

TASK: Fire main gun using primary sight (M-32).

Task Elements:

1. Upon receipt of the alert element of the fire command, places turret power switch in "on" position. (Alert)

2. Upon receipt of the ammunition element of the fire command, places main gun power switch in "on" position and coaxial machine gun switch to the appropriate position. (Select Gun)

3. Index appropriate ammunition into the computer, using the ammunition selector control. (Index Computer)

4. Upon receipt of the target element of the fire command, monitors unity window for target, and, when located announces, "Identified." (Monitor)

5. Upon receiving control, operates controls to place cross hairs of sight on center of target vulnerability. (Initial Aim)

6. Tracks target. (Track)

7. Upon receipt of execution element of fire command, checks final lay of the gun and applies appropriate lead. (Final Aim)

8. Hears, "Up," announces, "On the way," pauses one second, and squeezes trigger. (Fire)

.ASK: Adjust fire using Burst on Target (M-32 Sight).

Task Elements:

1. Upon firing, monitors sight for target and relays as necessary to reacquire the original sight picture. (Relay)

2. Senses the round (observes burst in relation to target, and determines new aiming point on reticle) and begins to relay. (Sense)

3. Operates controls to place new aiming point on center of target vulnerability. (Apply BOT)

4. Tracks target. (Track)

5. Hears, "Up," announces, "On the way," pauses one second, and squeezes trigger. (Fire)

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK ELEMENTS	DEVICE A	DEVICE B	DEVICE C
1. Alert	1	1	1
2. Select Gun	1	1	1
3. Index Computer	1	0	1
4. Monitor	1	1	1
5. Initial Aim	1	1	1
6. Track	0	1	1
7. Final Aim	1	1	1
8. Fire	1	1	1
9.			
10.			
Total number of 1's	7	7	8
Task Commonality Index	$\frac{7}{8+0}=.88$	$\frac{7}{8+1}=.78$	$\frac{8}{8+0}=1.0$
Task Commonality Index =	$\frac{\text{\# of 1's for Device}}{(\text{\# of Rq'd Task Elements}) + (\text{\# of Unique Element in Device})}$		

Figure III-11. Example Task Commonality Analysis

needed is included in the formula to reduce the final effectiveness score for those devices offering greater capability (and therefore cost more) than actually required.

A separate task commonality table is used for each task. You will see a second example, Task 2, at Figure III-12. How faithfully the element is represented in a training device is considered separately.

b. Physical Similarity. A physical similarity analysis is based on the physical similarity or fidelity of displays (cues) and controls (responses) in a training device when compared to the operational equipment. The following procedure is applied to each task. The first example is Task 1, shown in Figure III-13.

(1) List the controls and displays involved in task performance down the left column of Figure III-13.

(2) List the training devices or training device concepts to be assessed across the top of Figure III-13.

(3) For each control or display listed in the left column of Figure III-13, rate how well it is physically represented in each training device or device concept under consideration. Base your ratings of physical similarity on the four-point scale given in Table III-11.

Table III-11. Physical Similarity Rating Scale

Rating	Definition
3	Identical. The trainee would not notice a difference between the training device control or display and the operational control or display when he moves from the training to the job situation. Include for consideration the location, appearance, feel, and any other physical characteristics. Ignore the amount and quality of information transmitted.
2	Similar. There would be a small noticeable difference for the trainee between the training device control or display and the operational control or display, but he would be able to perform the task. There might be a decrement in performance, but any such decrement would be small and readily overcome.
1	Dissimilar. There would be a large noticeable difference quite apparent to the trainee, between the training device control or display and the operational control or display and a large performance decrement, given that the trainee could perform at all. Specific instruction and practice would be required on the operational equipment after practice on the training device to overcome the decrement.
0	Missing. The control or display is not represented at all in the training device.

NAME OF TASK Adjust Fire Using Burst on Target

REQUIRED TASK ELEMENTS	DEVICE A	DEVICE B	DEVICE C
1. Relay	0	0	1
2. Sense	1	1	1
3. Apply BOT	1	1	1
4. Track	0	1	1
5. Fire	1	1	1
6.			
7.			
8.			
9.			
10.			
Total number of 1's	3	4	5
Task Commonality Index	$\frac{3}{5+1} = .50$	$\frac{4}{5+0} = .80$	$\frac{5}{5+0} = 1.0$
Task Commonality = Index	$\frac{\text{\# of 1's for Device}}{(\text{\# of Rq'd Task Elements}) + (\text{\# of Unique Element in Device})}$		

Figure III-12. Example Task Commonality Analysis

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK CONTROLS AND DISPLAYS	DEVICE A	DEVICE B	DEVICE C
1. Earphone	0	0	0
2. ON/OFF Position of Turret Power Switch	2	3	3
3. Turret Power Toggle Switch	2	3	3
4. ON/OFF Position of Main Gun Toggle Switch	2	3	3
5. ON/OFF Position of Coaxial Machine Gun Switches	2	3	3
6. Coaxial Machine Gun Switch	2	3	3
7. Indexing Window	2	3	3
8. Indexing Handle Feedback	1	3	3
9. Indexing Handle	1	3	3
10. Unity Window	2	3	3

Continued on next page.

Figure III-13. Example Physical Similarity Analysis

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK CONTROLS AND DISPLAYS	DEVICE A	DEVICE B	DEVICE C
11. Microphone	0	0	0
12. Cadillac Control Feedback	0	3	3
13. M-32 Sight (target)	2	2	2
14. Reticle	2	3	3
15. Cadillac Elevating Traversing Control	1	3	3
16. Palm Switches	0	3	3
17. M-32 Sight (dynamic target)	0	2	2
18. Primary Sight	2	2	2
19. Trigger Switches	2	3	3
20.			
Sum of Physical Similarity Ratings	25	48	48
Physical Similarity Index	$\frac{25}{3(19)+2}$	$\frac{48}{3(19)+3}=.80$	$\frac{48}{3(19)+0}=.84$

Physical Similarity Index = $\frac{\text{Sum of Similarity Ratings for Device}}{3(=\text{ of Rq'd Controls \& Displays}) + (=\text{ of Controls \& Displays Unique to Device})}$

Figure III-13. Example Physical Similarity Analysis (concluded)

(4) Repeat the procedure for each training device or training device concept under consideration.

(5) For each training device or device concept under consideration add the ratings for each control and display listed to obtain a total score.

(6) Enter the total score for each device in Figure III-13.

(7) Total the number of controls and displays unique to a device or device concept in addition to the required set of controls and displays. These are controls and displays unrelated to the training requirements.

(8) Derive the physical similarity index value by dividing the sum of physical similarity ratings by three times the number of controls and displays plus the number of controls and displays unique to a device or device concept.

(9) Enter the physical similarity index value in Figure III-13.

A separate physical similarity table is used for each task. Our selected Task 2 is shown in Figure III-14. How faithfully the training device represents the functioning of the operational equipment is considered next.

c. Functional Similarity. The functional similarity analysis compares the operator's behavior in terms of the information flow from each display to the operator, and from the operator to each control. You will assess this in terms of the amount of information transmitted from each display to each control and the type of information-processing activity performed by the operator. The issue is not the physical fidelity of a control or display, but whether the operator acts on the same amount of information in the same way in both operational and training situations.

Controls and displays are considered together with task elements to determine the type, amount, and direction of information flow occurring during task performance. Each situation in which a display transmits information to the operator (e.g., reads it) is defined as a stimulus function, while each situation in which the operator transmits information to a control (e.g., operates it) is termed a response function.

In each, the amount of information may be estimated by the number of states or discrete values which the display or control may assume. The functional similarity is assessed by comparing the number of discrete values or states in the training situation. The range of values may be partitioned into four major levels: (1) continuous (essentially unlimited), (2) multivalued (some discrete value greater than two), (3) binary (two values), or (4) not represented. Figure III-15 shows performing functional similarity analysis for Task 1.

(1) List the controls and displays involved in task performance on the operational equipment down the left column of Figure III-15.

(2) List the training devices or training device concepts to be assessed across the top of Figure III-15.

NAME OF TASK Adjust Fire Using Burst on Target

REQUIRED TASK CONTROLS AND DISPLAYS	DEVICE A	DEVICE B	DEVICE C
1. Fire Feedback	0	0	0
2. M-32 Sight (target)	2	2	3
3. Reticle	2	3	3
4. Cadillac Elevating Traversing Control	1	3	3
5. Palm Switches	0	3	3
6. M-32 Sight (Burst)	1	1	2
7. M-32 Sight (Dynamic Target)	0	2	2
8. Earphones	0	0	0
9. Microphone	0	0	0
10. Trigger Switches	2	3	3
Sum of Physical Similarity Ratings	8	17	19
Physical Similarity Index	$\frac{8}{3(10)+2}=.25$	$\frac{17}{3(10)+2}=.53$	$\frac{19}{3(10)+0}=.63$

Physical Similarity Index = $\frac{\text{Sum of Similarity Ratings for Device}}{3(\text{\# of Rq'd Controls \& Displays}) + (\text{\# of Controls \& Displays Unique to Device})}$

Figure III-14. Example Physical Similarity Analysis

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK CONTROLS AND DISPLAYS	DEVICE A	DEVICE B	DEVICE C
1. Earphone	3	3	3
2. ON/OFF Position of Turret Power Switch	3	3	3
3. Turret Power Toggle Switch	3	3	3
4. ON/OFF Position of Main Gun Toggle Switch	3	3	3
5. ON/OFF Position of Coaxial Machine Gun Switch	3	3	3
6. Main Gun Toggle Switch	3	3	3
7. Coaxial Machine Gun Switch	3	3	3
8. Indexing Window	2	3	3
9. Indexing Handle Feedback	1	3	3
10. Indexing Handle	1	3	3

Continued on Next Page

Figure III-15. Example Functional Similarity Analysis

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK CONTROLS AND DISPLAYS	DEVICE A	DEVICE B	DEVICE C
11. Unity Window	2	2	2
12. Cadillac Control Feedback	0	3	3
13. M-32 Sight (target)	2	3	3
14. Reticle	3	3	3
15. Cadillac Elevating Traversing Control	2	3	3
16. Palm Switches	0	3	3
17. M-32 Sight (Dynamic Target)	0	2	2
18. Primary Sight	2	1	1
19. Trigger Switches	3	3	3
20.			
Sum of Functional Similarity Ratings	39	53	53
Functional Similarity Index	$\frac{39}{3(19)+4} = .64$	$\frac{53}{3(19)+3} = .88$	$\frac{53}{3(19)+0} = .93$

Functional Similarity Index = $\frac{\text{Sum of Similarity Ratings for Device}}{3(\#\text{ of Rq'd Controls \& Displays}) + (\#\text{ of Controls \& Displays Unique to Device})}$

Figure III-15. Example Functional Similarity Analysis (concluded)

(3) For each control or display listed in the left column of Figure III-15, note how well it is functionally represented in each training device under consideration. Base your ratings of functional similarity on the four-point scale given in Table III-12.

Table III-12. Functional Similarity Rating Scale

Rating	Definition
3	Identical. The number of states in the training situation is the same as the number of states in the operational setting.
2	Similar. The number of states in the training situation is at least half of the number of states in the operational setting.
1	Dissimilar. The number of states in the training situation is less than half of the number of states in the operational setting.
0	Missing. The control or display is not represented at all in the training device.

(4) Repeat the procedure for each training device or training device concept under consideration.

(5) For each training device or device concept under consideration add the ratings for each control and display listed to obtain a total score.

(6) Enter the total score for each device in Figure III-15.

(7) Total the number of controls and displays unique to a device or device concept in addition to the required set of controls and displays, if any such controls or displays exist.

(8) Derive the functional similarity index value by dividing the sum of functional similarity ratings by three times the number of controls and displays plus the number of controls and displays unique to a device or device concept.

(9) Enter the functional similarity index value in Figure III-15.

A separate functional similarity table is used for each task. Our second task is analyzed for functional similarity in Figure III-16.

d. Skill and Knowledge Requirements. This analysis assesses the skill and knowledge in the student's repertory before training and compares them to the skill and knowledge required for successful performance of the training tasks. Figure III-17 shows how this analysis is done for Task 1.

(1) List the skill and knowledge required for successful task performance down the left column of Figure III-17.

Figure III-16. Example Functional Similarity Analysis

NAME OF TASK Adjust Fire Using Burst on Target

REQUIRED TASK CONTROLS AND DISPLAYS	DEVICE A	DEVICE B	DEVICE C
1. Fire Feedback	0	0	0
2. M-32 Sight (target)	2	2	3
3. Reticle	3	3	3
4. Cadillac Elevating Traversing Control	2	3	3
5. Palm Switches	0	3	3
6. M-32 Sight (burst)	1	1	2
7. M-32 Sight (dynamic target)	0	2	2
8. Earphones	3	3	3
9. Microphone	3	3	3
10. Trigger Switches	3	3	3
Sum of Functional Similarity Ratings	17	23	25
Functional Similarity Index	$\frac{17}{3(10)+2} = .53$	$\frac{23}{3(10)+0} = .77$	$\frac{25}{3(10)+0} = .83$

Functional Similarity Index = $\frac{\text{Sum of Similarity Ratings for Device}}{3(\#\text{ of Rq'd Controls \& Displays}) + (\#\text{ of Controls \& Displays Unique to Device})}$

Figure III-17. Example Skill and Knowledge Requirements Analysis

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK SKILLS AND KNOWLEDGE	AFTER TRAINING	BEFORE TRAINING	DIFFERENCE (AFTER – BEFORE)
1. Know alert procedure	4	0	4
2. Know gun selection procedure	4	0	4
3. Know computer index procedure	4	0	4
4. Know monitor procedure	3	0	3
5. Know aim procedure	3	0	3
6. Know track procedure	4	0	4
7. Know final aim procedure	4	0	4
8. Know fire procedure	3	0	3
9. Know control/display location (alert)	4	0	4
10. Know control/display location (select gun)	4	0	4

Continued on next page

Figure III-17. Example Skill and Knowledge Requirements Analysis (continued)

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK SKILLS AND KNOWLEDGE	AFTER TRAINING	BEFORE TRAINING	DIFFERENCE (AFTER – BEFORE)
11. Know control/display location (index computer)	4	0	4
12. Know control/display location (monitor)	4	0	4
13. Know control/display location (initial aim)	4	0	4
14. Know control/display location (track)	4	0	4
15. Know control/display location (final aim)	4	0	4
16. Know control/display location (fire)	4	0	4
17. Operate M-32 Sight	4	0	4
18. Ammo-to-index value transformation	4	0	4
19. Target descriptors-to-target transformation	3	0	3
20. Recognize Targets visually	2	0	2

Continued on next page

Figure III-17. Example Skill and Knowledge Requirements Analysis (concluded)

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK SKILLS AND KNOWLEDGE	AFTER TRAINING	BEFORE TRAINING	DIFFERENCE (AFTER – BEFORE)
21. "center of vulnerability"	3	0	3
22. Aiming	3	0	3
23. Detect transfer of control	4	0	4
24. Tracking	3	0	3
25. Aim-off	4	0	4
26. Estimate one second	3	2	1
27. Lead	3	0	3
28. Operate control blindly (alert)	2	0	2
29. Operate control blindly (select gun)	2	0	2
30. Operate control blindly (index computer)	4	0	4
Total Difference Score			103
Skill & Knowledge Requirements Index			$\frac{103}{4(30)} = .86$

Skill & Knowledge Requirements Index = $\frac{\text{Total Difference Score}}{4 \text{ (Number of Skills \& Knowledge)}}$

(2) For each skill or knowledge listed in the left column of Figure III-17, estimate how "much" of the skill or knowledge the average trainee could be expected to have upon first exposure to the training device, and estimate how much of the skill and knowledge he must possess at training's completion. Use the two scales in Tables III-13 and III-14.

Table III-13. Rating Scale for Skills and Knowledge Before Training

Rating	Definition
4	Has a complete understanding of the subject or skill. Can do the task completely and accurately without supervision. Has received "skill" training.
3	Understands the subject or skill to be performed. Has applied part of the knowledge or skill either on the actual job or a trainer. Has done the job enough times to make sure he can do it, although perhaps only with close supervision. Has had "procedural" training.
2	Has received a complete briefing on the subject or skill. Can use the knowledge or skill only if assisted in every step of the operation. Requires much more training and experience. Has received "familiarization" training only.
1	Has only limited knowledge of this subject or skill. Has not actually used the information or skill. Cannot be expected to perform. Has had "orientation" only.
0	No experience, training, familiarity, etc., with this skill or knowledge. Canno* perform a task requiring this skill or knowledge.

Table III-14. Rating Scale for Skills and Knowledge After Training

Rating	Definition
4	Should have a complete understanding of the subject or be highly skilled. Is able to perform the task completely, accurately, and independently. Has had "skill" training.
3	Should have an understanding of the subject or skill to be performed. Has applied part of the knowledge or skill on the actual job or a trainer. Has done the job enough times to make sure he can do it although perhaps only with close supervision. Needs more practice under supervision. Has had "procedural" training.
2	Should have received a complete briefing on the subject or task. Is able to use the knowledge or skill only if assisted in every step of the operation. Requires much more training and experience to be able to perform the task independently. Has had "familiarization" training.
1	Should have limited knowledge of the subject or skill. Has not actually used the information. Is not expected to perform the task. Has completed "orientation" training.
0	At the end of training, the trainee should have no experience or training.

(3) Compute the differences between skill and knowledge requirements before and after training by subtracting the before-training value from the after-training value for each skill or knowledge. (Negative differences are set equal to zero, because they indicate the trainee enters with more skill than necessary.)

(4) Add the difference scores ("after" minus "before" ratings) for the skills and knowledges listed to obtain a total difference score.

(5) Enter the total difference score for each device in Figure III-17.

(6) Derive the skill and knowledge requirements index by dividing the total difference score by four times the number of skills and knowledges.

(7) Enter the skill and knowledge requirements index value in Figure III-17.

A separate skill and knowledge requirements table is used for each task. Task 2 is analyzed on Figure III-18.

Figure III-18. Example Skill and Knowledge Requirements Analysis

NAME OF TASK Adjust Fire Using Burst on Target

REQUIRED TASK SKILLS AND KNOWLEDGE	AFTER TRAINING	BEFORE TRAINING	DIFFERENCE (AFTER – BEFORE)
1. Know relay procedure	4	0	4
2. Know sense procedure	4	0	4
3. Know BOT application procedure	4	0	4
4. Know tracking procedure	4	0	4
5. Know fire procedure	4	0	4
6. Know control/display location (relay)	4	0	4
7. Know control/display location (sense)	4	0	4
8. Know control/display location (apply BOT)	4	0	4
9. Know control/display location (track)	4	0	4
10. Know control/display location (fire)	4	0	4

Continued on next page

Figure III-18. Example Skill and Knowledge Requirements Analysis (concluded)

NAME OF TASK Adjust Fire Using Burst on Target

REQUIRED TASK SKILLS AND KNOWLEDGE	AFTER TRAINING	BEFORE TRAINING	DIFFERENCE (AFTER – BEFORE)
11. Operate M-32 Sight	4	0	4
12. Aiming (Relay)	4	0	4
13. Sensing vs. Nonsensing	3	0	3
14. "Do not announce"	4	0	4
15. Sensing	3	0	3
16. Aiming (apply BOT)	3	0	3
17. Tracking	3	0	3
18. Estimate one second	3	2	1
19.			
20.			
Total Difference Score			65
Skill & Knowledge Requirements Index			$\frac{65}{4(18)} = .90$

Skill & Knowledge Requirements Index = $\frac{\text{Total Difference Score}}{\text{4 (Number of Skills \& Knowledge)}}$

e. Task Training Difficulty. A task training difficulty analysis estimates the difficulty (in terms of training time) of training soldiers to successfully perform the required tasks. Ratings are assigned based on the assumption that training occurs on the operational equipment. Figure III-19 shows this analysis for Task 1.

(1) List the task elements down the left column of Figure III-19.

(2) For each task element listed, rate the amount of training time for surmounting its associated deficit relative to the most time-consuming task element. Table III-15 is used.

Table III-15. Task Training Difficulty Rating Scale

Rating	Definition
4	Requires as much time to train as the most time-consuming task element, considering all task elements for all tasks in the current analysis
3	Requires substantial training time, but less than above
2	Requires a moderate amount of training time relative to the most time-consuming task element
1	Requires only minimal training time relative to the most time-consuming task element
0	Requires no training time

(3) Add the training difficulty ratings for the task elements listed to obtain a total training difficulty score.

(4) Enter the total training difficulty score in Figure III-19.

(5) Derive the task training difficulty index by dividing the total training difficulty score by four times the number of task elements.

(6) Enter the task training difficulty index value in Figure III-19.

A separate task training difficulty table is used for each task (see Figure III-20 for Task 2). Note, however, the rating scale is used by evaluating training time for each task element relative to the most time-consuming element for all tasks in the current analysis.

Figure III-19. Example Task Training Difficulty Analysis

NAME OF TASK Fire Main Gun Using Primary Sight

REQUIRED TASK ELEMENT	TRAINING DIFFICULTY
1. Alert	1
2. Select gun	2
3. Index computer	3
4. Monitor	3
5. Initial aim	4
6. Track	4
7. Final aim	4
8. Fire	2
9.	
10.	
Total Training Difficulty Score	23
Task Training Difficulty Index = $\frac{\text{Total Training Difficulty Score}}{4(\text{Number of Task Elements})}$	$\frac{23}{4(8)} = .72$

Figure III-20. Example Task Training Difficulty Analysis

NAME OF TASK Adjust Fire Using Burst on Target

REQUIRED TASK ELEMENT	TRAINING DIFFICULTY
1. Relay	2
2. Sense	3
3. Apply BOT	4
4. Track	4
5. Fire	1
6.	
7.	
8.	
9.	
10.	
Total Training Difficulty Score	14
Task Training Difficulty Index = Total Training Difficulty Score / 4(Number of Task Elements)	$\frac{14}{4(5)} = .70$

f. Index of Training Device Effectiveness. From the five analyses just completed you will derive overall indexes of effectiveness for each training device or training device concept under consideration.

- o Task commonality
- o Physical similarity
- o Functional similarity
- o Skill and knowledge requirements
- o Task training difficulty

The task commonality, physical similarity, and functional similarity analyses were conducted on a task-by-task basis for each training device or training device concept. The skill and knowledge requirements and task training difficulty analyses were independent of any particular device and addressed specific personnel and training requirements. The following procedure is used to derive task level training effectiveness indexes.

(1) List the tasks requiring training down the left column of Figure III-21.

(2) Obtain task commonality, physical similarity, and functional similarity index values derived in previous analyses (Figures III-11, III-13, III-15) for each task as listed on Figure III-21.

(3) Enter these values in the appropriate columns of Figure III-21.

(4) For each task, add the listed task commonality, physical similarity, and functional similarity scores and divide by three. The obtained value indicates the degree of correspondence between the operational equipment and the particular training device for that task.

(5) Repeat this analysis for each training device (see Figures III-22 and III-23).

g. Personnel and Training Requirements Analysis. The next analysis summarizes the personnel and training requirements analyses.

(1) List the tasks requiring training down the left column of Figure III-24.

(2) Obtain the skill and knowledge requirements and task training dificulty index values derived in previous analyses (Figures III-17 and III-19) for each task listed in Figure III-24.

(3) Enter these values in the appropriate columns of Figure III-24.

(4) For each task, add the listed skill and knowledge requirements and task training difficulty index values and divide by two. The obtained value indicates the extent of training required based on skills and knowledge requirements and abilities of the typical trainee.

Figure III-21. Example Training Device and Operational Equipment Task Level Correspondence

NAME OF DEVICE A

REQUIRED TASKS	TASK COMMONALITY (TC)	PHYSICAL SIMILARITY (PS)	FUNCTIONAL SIMILARITY (FS)	$\frac{TC + PS + FS}{3}$
1. Fire Main Gun	.88	.42	.64	.65
2. Adjust Fire	.50	.25	.53	.43
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Figure III-22. Example Training Device and Operational Equipment Task Level Correspondence

NAME OF DEVICE B

REQUIRED TASKS	TASK COMMONALITY (TC)	PHYSICAL SIMILARITY (PS)	FUNCTIONAL SIMILARITY (FS)	$\frac{TC + PS + FS}{3}$
1. Fire Main Gun	.78	.80	.88	.82
2. Adjust Fire	.80	.53	.77	.70
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Figure III-23. Example Training Device and Operational Equipment Task Level Correspondence

NAME OF DEVICE C

REQUIRED TASKS	TASK COMMONALITY (TC)	PHYSICAL SIMILARITY (PS)	FUNCTIONAL SIMILARITY (FS)	$\frac{TC + PS + FS}{3}$
1. Fire Main Gun	1.0	.84	.93	.92
2. Adjust Fire	1.0	.63	.83	.82
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Figure III-24. Example Task Level Personnel and Training Requirements

NAME OF DEVICE A, B, C

TASKS	SKILL & KNOWLEDGE REQUIREMENTS (SKR)	TASK TRAINING DIFFICULTY (TTD)	$\frac{SKR + TTD}{2}$
1. Fire Main Gun	.86	.72	.79
2. Adjust Fire	.90	.70	.80
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

h. Overall Training Device Effectiveness Index. The final analysis derives overall training device effectiveness indexes for each device or device concept by combining the task level training device and operational equipment correspondence analysis and the task level personnel and training requirements analysis.

(1) List the tasks requiring training down the left column of Figure III-25.

(2) List the training devices or training device concepts to be assessed across the top of Figure III-25.

(3) Obtain the $\frac{TC + PS + FS}{3}$ and $\frac{SKR + TTD}{2}$ values for each task and for each training device from Figures III-23 and III-24 and enter them in the appropriate columns of Figure III-25.

(4) Multiply the $\frac{TC + PS + FS}{3}$ and $\frac{SKR + TTD}{2}$ values for each task and enter in the appropriate column labeled product.

(5) Add the product values for all tasks and enter the sum in the sum of products location for that device.

(6) Add the $\frac{SKR + TTD}{2}$ values for each task and enter the sum in the sum of $\frac{SKR + TTD}{2}$ location for that device.

(7) Divide the value from Step 5 ("A") by the value from Step 6 ("B"). This value is the training device effectiveness index for that training device concept.

(8) When comparing alternative existing device concepts, an effectiveness index is adjusted by multiplying it by:

$$\frac{\text{\# of Required Tasks}}{(\text{\# of Required Task}) + (\text{\# of Tasks Unique to the Alternative})}$$

This factor accounts for capabilities within an existing device that are not required for the device under consideration. Capabilities not required mean additional cost, and this correction factor adjusts the effectiveness score to reflect a loss of effectiveness due to unnecessary cost. Where a theoretical device concept is being considered, there probably will be no tasks unique to it and the correction factor is not used.

(9) Repeat the procedure for each training device or training device concept under consideration.

Thus you can report that a predicted overall highest effectiveness may be expected from the new device, C, next from device B and lowest from A. These may now be used in cost effectiveness analysis. For a costing methodology see Section IIID, Costing of Training Programs - The Litton Cost Model (p. III-77).

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COST AND TRAINING EFFECTIVENESS ANALYSIS (CTEA) PERFORMANCE GUI--ETC(U)
SEP 80 R K MATLICK, D C BERGER, M H ROSEN MDA903-79-C-0326
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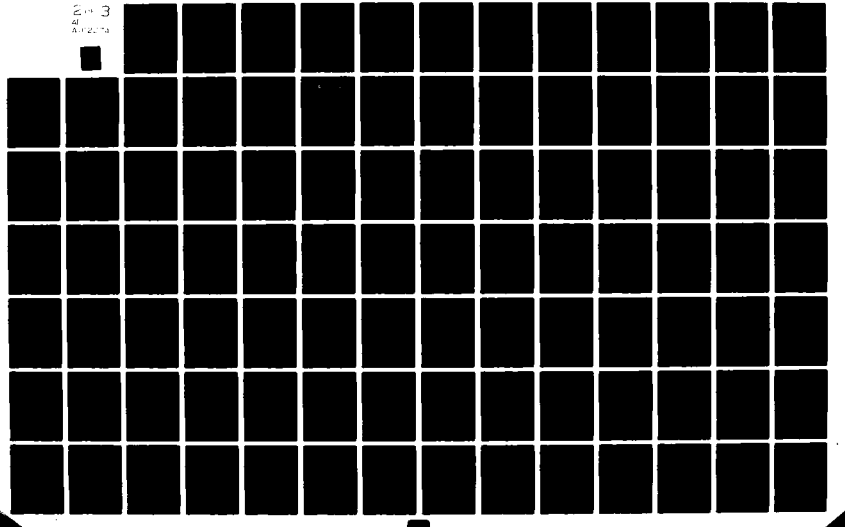

Figure III-25. Example Training Device Effectiveness Index

TASKS	DEVICE A			DEVICE B			DEVICE C		
	$\frac{TC+PS+FS}{3}$	$\frac{SKR+TTD}{2}$	PRODUCT	$\frac{TC+PS+FS}{3}$	$\frac{SKR+TTD}{2}$	PRODUCT	$\frac{TC+PS+FS}{3}$	$\frac{SKR+TTD}{2}$	PRODUCT
1. Fire Main Gun	.65	.79	.51	.82	.79	.65	.92	.79	.73
2. Adjust Fire	.43	.80	.34	.70	.80	.56	.82	.80	.66
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
Ⓐ Sum of Products			.85			1.21			1.39
Ⓑ Sum of $\frac{SKR + TTD}{2}$		1.59			1.59			1.59	
Training Device Effectiveness Index	.53			.76			.87		

$$\text{Training Device Effectiveness Index} = \frac{A}{B} \times \frac{\text{\# of Required Tasks}}{(\text{\# of Rq'd Tasks}) + (\text{\# of Tasks Unique to Alternative Device Concept})}$$

5. TCA. Hawley and Thomason, Development of an Air Defense Cost and Training Effectiveness Analysis Methodology, 2 vol., 1978.

TCA makes use of a computer program, but before you use it you will need to manually prepare the input data. Instructions with the program will tell you how to input the data you have prepared. The following procedure will lead you step by step through the preparation of the input data and the interpretation of the output information.

Preparation of Input Data

Step 1. You will need a number of TCA Worksheets equal to the number of tasks you are considering times the number of training program alternatives to be compared (tasks in task list x number of alternatives). Thus, if you were to consider twenty tasks and three different training program alternatives, you would need at least sixty worksheets. You may make your own or make photocopies of the one in Appendix 1 of Annex E.

Step 2. Organize the tasks you are going to consider into groups of tasks that will be trained together.

Step 3. For each task prepare a separate TCA Worksheet by recording the four-digit task number at the top of the sheet. Record the identification of the training program alternative also, and then prepare an additional worksheet for each additional training program alternative. That is, for each task you will prepare a worksheet for each training alternative of that task. See Figures III-26 and III-27.

Step 4. For each task prepare a task description by performing the following substeps:

a. Compare the task with each of the stimuli characteristics given in Annex A (TEEM). On the worksheet under Stimulus Characteristics, and under the number that corresponds to the number of the stimulus characteristic, record a "1" for each characteristic that applies and a "0" for each characteristic that does not apply. See Figures III-26 and III-27 for examples. Record these same numbers on each worksheet for the same task. (You must be thoroughly familiar with the task and have a valid reason for including a variable in the description of it. See Appendix 2, Annex E for examples of reasons for including a variable in a task description.)

b. Compare the task with each of the response characteristics given in Annex A (TEEM). On the worksheet, under Response Characteristics and under the number that corresponds to the number of the response characteristics, record a "1" for each characteristic that applies and a "0" for each that does not apply. See Figures III-26 and III-27 for examples. Record these same numbers on each worksheet for the same task.

c. Compare the task with each of the information feedback logic variables given in Annex A. On the worksheet, under Feedback Logic and under the number that corresponds to the number of the feedback variable, record a "1" for each feedback variable that applies and a "0" for each that does not apply. See Figures III-26 and III-27 for examples. Record these same numbers on each worksheet for the same task.

TCA WORKSHEET

TASK NO. 3100 ALT. A

TASK DESCRIPTION

STIMULUS CHARACTERISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	1	1	0	0	0	0	1	1	1	0	0	0	1	1	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	1

RESPONSE CHARACTERISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	1	0	1	0	1	0	1	0	1	0	1	0	0	1

FEEDBACK LOGIC

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	1

FUNCTIONAL CONTEXT

1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	0	0	1	1	1	0	1	1	0	1	0

TRAINING DESCRIPTION

STIMULUS MEDIA

5	6	11	35		

RESPONSE MEDIA

6	35				

FEEDBACK MEDIA

6	35				

METHODS

3	6				

Figure III-26. TCA Worksheet

TCA WORKSHEET

TASK NO. 3100 ALT. B

TASK DESCRIPTION

STIMULUS CHARACTERISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	1	1	0	0	0	0	1	1	1	0	0	0	1	1	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	1

RESPONSE CHARACTERISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	1	0	1	0	1	0	1	0	1	0	1	0	0	1

FEEDBACK LOGIC

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	1

FUNCTIONAL CONTEXT

1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	0	0	1	1	1	0	1	1	0	1	0

TRAINING DESCRIPTION

STIMULUS MEDIA

5	6	8	33		

RESPONSE MEDIA

6	8	33			

FEEDBACK MEDIA

6	8	33			

METHODS

3	6	10			

Figure III-27. TCA Worksheet

d. Compare each task group given with the functional context variables given in Annex A (TEEM). For each task in the task group, under the number that corresponds to the number of the functional context variable, record a "1" for each variable that applies and a "0" for each that does not apply. See Figures III-26 and III-27 for examples. Record these same numbers on each worksheet for the same task.

Step 5. For each training program alternative of each task prepare a training description by performing the following substeps:

a. Search through the list of training equipment and materials in Annex A (TEEM) to find the stimulus media of each alternative training program of each task. (Stimulus media are the means through which information is presented to the student.) In the training description part of the worksheet, under Stimulus Media, record the number of the media. See Figures III-26 and III-27. (You must be thoroughly familiar with each training program alternative so that you can properly identify each medium employed in the training of each task.)

b. Search through the list of training equipment and materials in Annex A (TEEM) to find the response media of each alternative training program of each task. (Response media are the means by which the student demonstrates that he has learned; they are the things on which the student acts as he responds.) In the training description part of the worksheet, under Response Media, record the numbers of the media. See Figures III-26 and III-27.

c. Search through the list of training equipment and materials in Annex A (TEEM) to find the feedback media of each alternative training program of each task. (Feedback media are the means through which the student is informed of the correctness of his response.) In the training description part of the worksheet, under Feedback Media, record the number of the media. See Figures III-26 and III-27.

d. Search through the list of training methodologies in Annex A (TEEM) to find the training methods for each task group in each training program alternative. For each task in the task group, record the numbers of the methods on the worksheet under Methods. See figures III-26 and III-27.

Step 6. You now have a description of each task to be considered and a description of each alternative training program of each task. Sort the TCA Worksheets by training program alternative. Within the stack of worksheets representing each alternative training program arrange the worksheets by task group. When you are finished, you will have a stack of TCA Worksheets for each training program alternative you are examining. Within each stack, the worksheets will be arranged by task group.

You are now ready to go to a computer center or a computer terminal to enter your data. You will enter a separate set of data for each training program alternative you are examining.

Interpretation of the Output Information

You will get your TCA output information in the form of computer printout. You will get separate pages of printout for each training program alternative. You will interpret the output information by performing the following steps:

Step 1. (Refer to Figure III-28. The format of the printout you get may not be exactly like that given in Figure III-28, but you will find the same information.) First, for each task as trained by each alternative training program, examine the information indicated by (1) in Figure III-28. These are the 85 task description numbers you have entered for the task (i.e., the 39 numbers of stimulus characteristics plus the 16 numbers of response characteristics plus the 17 numbers of feedback logic plus the 13 numbers of functional context equal 85). Compare them with the TCA Worksheet to verify that they are correct. Then, check the information indicated by (2) in Figure III-28. This information must include the numbers under Training Description in the TCA Worksheet. In the example given in Figure III-28, programmed text (8) was the stimulus medium, the response medium, and the feedback medium. The methods were performance-manual-independent practice (6) and programmed instruction (10).

Step 2. Examine the training deficiencies, redundancies, and excesses to get an idea of the nature of the match between the task descriptions and the training descriptions. This information may be of value to you when you compare training program alternatives and recommend revisions. (A training deficiency means that a characteristic in the task description is not matched by the training description. A training excess means that there is a capability in the training description not required by the task description. A training redundancy means that two or more media or methods match the same task characteristics.) The numbers of deficiencies, excesses, and redundancies are indicated by (3) in Figure III-28. The nine deficiencies (i.e., characteristics in the task description that are not matched by the training description) are indicated by (4) in Figure III-28. (Note that in this printout task characteristics are numbered sequentially across stimulus characteristics, response characteristics, information feedback logic, and functional context -- 39 + 16 + 17 + 13 = 85). See Annex A (TEEM). The two redundancies in this example (5) show that the two methods in the training description (6 and 10) both match the task characteristics shown (75 and 81). This information may indicate media or methods that can be eliminated from the training program without harming training effectiveness. The 7 training excesses in the example in Figure III-28 are indicated by (6). This information, too, may indicate media or methods that can be eliminated from a training program without harming training effectiveness.

Step 3. Examine statistics for each task and each task group. In Figure III-29, (1) indicates the statistics by task. The numbers in the row labeled COINCIDENCES show how many matches there were between the task description and the training description. For Task 3302, for example, there were 20 matches between the task description and the training description. The numbers in the row labeled TASK SUM show how many task characteristics there were in the task description. For Task 3302, for example, there were 29 such characteristics. The numbers in the row labeled CON. RATIO are the Training Consonance Ratios (TCR) of each task. The TCR is, simply, the coincidences over the task sum (20/29 = .687). In Figure III-29 (2) indicates this same information for a whole task group. Information similar to that indicated by (2) in Figure III-29 will also be given for all tasks.

Step 4. Establish the TCR level that represents acceptable training effectiveness. This step is based on judgment to be refined by experience, but a TCR below .600 should probably be considered to represent unacceptable training effectiveness.

TASK GROUP 2

LISTING OF TASKS AND COLUMNS SELECTED

TASK 33021 1. 0. 0. 0. 0. 0. 0. 1. 1. 1. 0. 1. 0. 1. 1. 0. 0. 1. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0.
0. 1. 0. 1. 0. 1. 0. 1. 0. 0. 1. 1. 0. 1. 0. 1. 0. 1. 0. 1. 0. 1. 0. 1. 0. 1. 0. 0. 0. 0.
0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 0. 0. 0. 1. 0. 0. 1. 0. 0. 1. 1. 0. 1. 0.

COLUMNS: STIMULI
0
RESPONSE
0
FEEDBACK
0
METHOD
0
10

DEFICIENCIES-- 9
EXCESS------- 7
REDUNDANCES-- 2

TRAIN. CHAR. DEP.

12-VIS. SOLID OBJ. 18-VIS. LIM. MOVE. 32-DYNAMIC-COHERED 34-SLOW RATE 42-D. RESP. MAN. AC 46-STRONG
50-VISUAL 70-SYSTEM STATUS 84-LOW IMPACT

TRAIN. CHAR. REDUN.

75-INDIVIDUAL PERF. 81-STABLE

TRAIN. CHAR. EXCESS.

24-PROPOR. SCALE 31-STATIC 81-FAST RATE 88-WRITTEN FORM 89-INTRINSIC P 97-RES. CONNECT.
77-PHYSICAL

Figure III-28. Format of Printout (from Hawley and Thomason, 1978)

TASK	3302	3303	3401	3402	3403	3404	3405	3406	3730	3800
COINCIDENCES	20.0	17.0	17.0	17.0	18.0	20.0	18.0	18.0	19.0	19.0
TASK SUM	29.0	25.0	28.0	24.0	28.0	30.0	28.0	28.0	31.0	31.0
CON. RATIO	0.690	0.680	0.607	0.708	0.643	0.667	0.643	0.643	0.613	0.613

GROUP STATISTICS

COINCIDENCES---183.0
GROUP SUM---- 287.0
CON. RATIO--- 0.649

(After the statistics for the last group run, a set of overall statistics will be printed, including total number of coincidences, sum of all task descriptors, and the overall Training Consonance Ratio based on these figures).

Figure III-29. Statistics by Task (from Hawley and Thomason, 1978)

D. Costing of Training Programs - The Litton Cost Model

Introduction

The cost factors you will use in this model generally fall into five categories:

- o facilities (classrooms, laboratories, learning centers, etc.)
- o equipment (projectors, simulators, learning carrels, etc.)
- o instructional materials (texts, films, slides, TEC lessons, etc.)
- o personnel (students, instructors, support personnel, etc.)
- o miscellaneous (ammunition, POL, parts, other consumable supplies)

The cost elements that make up these categories are represented by FORTRAN names. Each is defined the first time it is used. There is also a Glossary of Cost Variables as Appendix 1 to Annex D.

The model is designed to estimate the training costs of initial training proficiency on the system under study. For those tasks trained to proficiency in the institution, proficiency is assumed when the student passes his/her end-of-course tests. For those critical tasks not trained in the institution or trained only to familiarity, proficiency is assumed when the soldier successfully completes the appropriate Skill Qualification Test (SQT). Thus, refresher training or unit effectiveness training beyond this point is not relevant to this model.

Although the model can develop an estimate of the absolute costs of a system, it may also be used to compare costs of competing systems. In the latter case, care must be exercised to ensure a common basis for comparison, i.e., the same cost factors are considered for both systems. Since the CTEA process is dynamic and occurs at several points in the life cycle system, the amount and type of input data will vary. Obviously, you can expect less system data at the early stages of the system development process. If an analogous task has been identified, then the cost of training that task will have to be used since it has been chosen because data on the developing system is lacking. You may have to modify the analogous task data on the basis of common sense. For example, if you are studying some sort of laser individual weapon and find an analogous task for the M16A1 rifle, it would not make sense to use the cost of the M16A1 rifle in the cost computations. Get the estimated cost of the laser weapon from its Program/Project/Product Manager (PM), potential manufacturer(s), or from a laser expert and use it. Further, remember that you are costing only those units required for initial proficiency training -- not for equipping the whole Army. If there is insufficient data available on the developing system and no analogous tasks can be identified, it may well be that you cannot develop the cost estimates. However, you should recognize that there may be subject matter or other experts whose estimates of costs can be used if necessary. It may be that you can proceed to estimate the costs without certain cost factors that are unavailable. Again, you should ensure comparability of factors between competing systems. It is also essential that you explicitly indicate

in your analysis those factors that have been omitted until data become available. You can expect that the quality and quantity of the data will be upgraded as the system proceeds through its development stages or phases of its life cycle.

For most purposes costs in thousands of dollars to the nearest hundred will suffice, e.g., $5,610 would be represented as $5.6. However, this should be governed by your own good judgment to ensure that undue effort is not expended to develop accuracy in some variables that is not justified by the rough estimates of other variables. This is especially important in the early stages of development of the system.

Since the CTEA methodology considers the possible use of analogous tasks, there is another important caution. The following cost model may be used for estimating the costs of training of tasks or of the system. When using the model with task data, the system costs are then obtained by summing the costs of the tasks. You must be sure that you consider certain costs only once (e.g., cost of acquiring training equipment) if, in fact, the equipment, materials, etc. required for these costs are applicable to more than one task.

Procedures

The cost model is intended to be an automated model. Examples of manual computations have been included in the text to help you develop the input data for the model and to further explain the model. In some cases you will note that a final dollar value for the variable is not shown. These computations are incomplete because they do not readily lend themselves to being done manually. The total training costs of concern consist of the initial proficiency training that takes place in the institutions or schools and that which takes place in the units. This is represented by Equation 1.

$$TVALUE = IVALUE + UVALUE \quad (1)$$

where

TVALUE = total costs attributable to initial training on the task or system being studied.

IVALUE = the total costs associated with institutional training of the task system.

UVALUE = the total costs associated with initial proficiency training in the unit, i.e., until the soldier passes the appropriate SQT. For those tasks trained to proficiency in the institution, this variable = 0.

Institutional training costs are further divided into base training (e.g., classroom, learning centers) and field training conducted by the institution. This is shown in Equation 2.

$$IVALUE = BVALUE + FVALUE \quad (2)$$

where

BVALUE = the total training costs associated with institutional base training.

FVALUE = the total training costs associated with institutional field training.

By substitution:

$$TVALUE = BVALUE + FVALUE + UVALUE \quad (3)$$

DOD requires that costs and benefits in CTEA type analyses be in terms of present value (or discounted) form. The discount rate is prescribed as 10 percent. Since all materials, facilities, and equipment acquired for training may not be consumed during the initial proficiency training period, there will be a remaining value of these assets. This remaining value is treated as a reduction in the cost of the alternative for which the use of the assets is intended. The fair market value may be determined from sale price, scrap value, or alternative use value. Thus the present value (i.e., costs) of institutional base training is given by Equation 4.

$$BVALUE = \sum_{i=1}^{N} \frac{BDACST(i)}{(1+d)^{(i-1)}} - \frac{BRVAST}{(1+d)^{N}} \quad (4)$$

where

BDACST(i) = the total institutional base training non-discounted costs for the year i. The notation (i) following a variable name indicates that that particular variable may have a value which changes from year to year, since i represents the year measured from "today".

BRVAST = the total remaining value of materials, facilities, and equipment at the end of the planning period (N years).

N = the number of years in the planning horizon or life cycle of the system. If it is expected that training to initial proficiency on the task or system will continue for 10 years, for example, then N=10.

d = discount rate (DOD Instruction 7041.3 prescribes 10 percent).

Equation 4.1 is the basic constitutive equation reflecting the breakdown of costs into associative element costs.

$$BDACST(i) = BFACOS(i) + BFMCOS(i) + BEAQCI(i) + BEMQCI(i) + BACIMD(i) + BAIMMC(i) + BSUPPY(i) + BCINST(i) + BPALST(i) + BTRANS(i) \quad (4.1)$$

where

BFACOS(i) = cost of institutional base training facility acquisition in year i, attributable to training the particular task or system. If a facility is to be shared, take a pro rate share based on ratio of the students being trained on the task or system being studied to the total number of students using the facility. In the case of existing facilities the costs of which have been amortized and there is no alternative planned use for the facility or if no facilities need to be acquired, the factor BFACOS(i) = 0. In the case of an existing facility whose costs are not amortized or for which there are alternative uses or possible sale, the imputed value of the facility should be used. These costs can be based on fair market value, scrap value, or alternative use. In any event, discuss this variable with the Director of Industrial Operations (DIO) who can probably give you good advice and cost data for this variable.

You should also examine any TRADOC Form 124-R, Resource Summary Supplement, Other Requirements, submitted to TRADOC in accordance with TRADOC Circular 351-3, Training Requirements Analysis System (TRAS), Individual Training Plan (ITP) (Figure 1). These forms show projected MCA and OMA minor construction costs.

BFMCOS(i) = total cost of institutional base training facilities maintenance in year i.

BEAQCI(i) = total cost of institutional base training equipment acquisition in year i

BEMQCI(i) = total cost of institutional base training equipment maintenance in year i

BACIMD(i) = total cost of institutional instructional material development in year i

BAIMMC(i) = total cost of maintenance of institutional instructional material development in year i

BFACOS(i) = cost of institutional base training facility acquisition in year i attributable to training the particular task or system

EXAMPLE:

New facilities are not required to train this task but two existing, vacant maintenance sheds will be modified by constructing partitions and moving electrical outlets. The DIO estimates the cost per shed will be $1500. But this modified facility will be used to train three other tasks of the system as well. The percentage of time that it will be used to teach the particular task we are interested in is .25.

BFACOS(i) = .25 • $1500 • 2 = $750 = $.8 (thousands)*

*The symbol • means "multipled by." Do not confuse with decimal point.

RESOURCE SUMMARY SUPPLEMENT
OTHER REQUIREMENTS

(TRADOC Cir 351-3)

MCA PROJECT/OMA MINOR CONSTRUCTION

Project No	Description	Date Required	Cost

ARMY PROCUREMENT REQUIREMENTS

Appropriation	Nomenclature/NSN	Quantity	Date Required	Cost

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8 x 10½

Figure 1.

BSUPPY(i) = total cost of supplies consumed in year i in institutional base training

BCINST(i) = total cost of pay and allowances of all instructors in institutional base training in year i

BPALST(i) = total cost of pay and allowances of students in institutional base training in year i

BTRANS(i) = total cost of travel (including per diem) and equipment transportation in connection with institutional training in year i, and

The variables in Equation 4.1 are further defined as follows:

$$BFMCOS(i) = BTSQFT(i) \bullet BCSQFT(i) \qquad (4.11)$$

where

BTSQFT(i) = total square feet of institutional base training facilities required in year i

BCSQFT(i) = cost per square foot of operation and maintenance of training facilities in year i (includes operation, janitorial services, utilities, etc.). Either the DIO or Director of Facilities Engineering at your installation should be able to furnish data on this item.

and where:

$$BTSQFT(i) = [BSQFST + BINSTR \bullet SQFTIN] \bullet MESL(i) + BSQFTA \qquad (4.111)$$

where

BSQFST = number of square feet of institutional base training facilities required for each student (assumed constant over entire planning period). Possible sources of data are the DIO, the Management Analysis Division, and input data to TRADOC Form 273-R (Figure 2) submitted in accordance with TRADOC Reg 11-12. In the absence of any other better data, you could use an average figure of 44 sq ft per student for classroom space; 95 sq ft per student for laboratory space, and 68 sq ft per student for combination classroom/laboratory space.*

*Adapted from data in Hess and Kantar, MODIA: Vol. 5, A User's Guide to the Cost Model.

BTSQFT(i) = total square feet of institutional base training facilities required in year i

= [BSQFST + (BINSTR • SQFTIN)] • MESL(i) + BSQFTA

EXAMPLE:

The DIO informs you that, for this task, the number of square feet required per student (BSQFST) is 80 and the number of square feet per instructor (SQFTIN) is 60.

The Management Analysis Division tells you that the ratio of instructors to students (BINSTR) for this task is 1:10 or .1 and the maximum expected student load (MESL(i)) is 20.

The DIO also estimates the total square feet of administrative space (BSQFTA) attributable to training this system as 100. DTD has told you that training this task will take 25 percent of the system training time.

BTSQFT(i) = [80 + (.1 • 60)] • 20 + (100 • .25)

= 86 • 20 + 25

= 1745 sq. ft.

BFMCOS(i) = total cost of institutional base training facilities maintenance in year i.

= BTSQFT(i) • BCSQFT(i)

EXAMPLE:

The total square feet of facilities for this task has been computed as 1745 square feet.

The Director of Facilities Engineering informs you that he uses a constant maintenance cost per square foot of $2.00 per year (for janitorial services, utilities, and general upkeep).

BFMCOS(i) = 1745 • 2 = $3490 = $3.5 (thousands)

INSTALLATION POPULATION PROFILE

(TRADOC Reg 11-12)

Fiscal Year

Requirements Control Symbol: ATRM-S4 (R1)

Installation

LINE	Population Categories a	Man-Years Supported: Military b	Civilian c	Total d	Square Feet of Buildings(000): Occupied e	Vacant f
1	GARRISON: 1/					
2	Garrison TDA					
3	Band					
4	MP Unit					
5	Other					
6	TENANTS (On Post):					
7	STRAF TOE (P2)					
8	ATC (PP) 2/					
9	Reception Station (PP) 2/					
10	Schools (PP) (List each separately): 2/					
11						
12						
13						
14	NCOA					
15	DSS					
16	School Troops (PE814771.5)					
17	MEDDAC (P8M)					
18	TSA (P7)					
19	USACC (P3)					
20	Reserve Components:					
21	Annual Training					
22	Inactive Duty Training					
23	Recepteers 2/					
24	Transients					
25	Other Tenants 3/					
26	STUDENTS (List each school separately): 2/					
27						
28						
29						
30	NCOA					
31	DSS					
32	TRAINEES: 2/					
33	BT					
34	AIT/CST					
35	OSUT					
36	SUBTOTAL MAN-YEARS SUPPORTED					

TRADOC Form 273-R Oct 79

Figure 2.

figure of 44 sq ft per student for classroom space; 95 sq ft per student for laboratory space, and 68 sq ft per student for combination classroom/laboratory space.*

BINSTR = ratio of instructors to students in institutional base training (assumed constant from year to year). These data should be available in school Management Analysis Division or similar office or Director of Instruction.

SQFTIN = number of square feet of facilities required per instructor (assumed constant). See sources for BSQFST above.

BSQFTA = total square feet of facilities required for administration associated with initial training on the system. See sources for BSQFST above.

MESL(i)= maximum expected student load in year i.

$$BEAQCI(i) = BEQIMP(i) \bullet MESL(i) + BEQCIS(i) \qquad (4.12)$$

where

BEQIMP(i) = cost per student of the variable-cost institutional base training equipment that must be acquired in year i. Variable-cost resources relate directly to workload and change as the workload level changes over a relevant range. Refer to TRADOC Form 811-R, TRADOC Equipment Data (Figure 3), submitted in accordance with TRADOC Reg 11-5. The Audio-Visual Equipment Directory is also useful in this respect.*

BEQCIS(i) = total cost of fixed-cost institutional base training equipment acquired in year i. Fixed-cost (or static) resources are not responsive to changes in the workload (such as number of students) over a relevant range. You should check data submitted to TRADOC in accordance with TRADOC Reg 11-5 and TRADOC Cir. 351-3. TRADOC Form 811-R (Figure 3) was mentioned above under BEQIMP(i). The Individual Training Plan Proposal (ITPP) will list any projected new or revised extension products by type (e.g., TEC). TRADOC Form 125-R, Resource Summary FY ____, will identify by fiscal year by element of expense (EOE) the OMA dollars required (Figure 4). TRADOC Form 124-R will show requirements for major equipment items not funded from the OMA appropriation (Figure 1). Training Aids Service Offices (TASO) are also possible sources for data as well as PM TRADE.

$$BEMQCI(i) = BCOPMT(i) \bullet SI(i) + BOMFEQ(i) \qquad (4.13)$$

where

BEAQCI(i) = total cost of institutional base training equipment acquisition in year i.

= BEQIMP(i) • MESL(i) + BEQCIS(i)

EXAMPLE:

In order to train this task each student will have a Beseler Cue/See. TRADOC Form 811-R, TRADOC Equipment Data shows that the acquisition value is $14,300 (20 students + 10 percent spares = 22 units at $650 each). TRADOC Form 811-R also shows two 35mm projectors at a total acquisition value of $1250 are required for training the system. Since training this task takes 25 percent of the course time,

BEAQCI(i) = 14,300 + 1250 • .25

= 14,300 + 312.50

= $14.6 (thousands)

You are also advised by the TASO that you should count on replacing the Beseler Cue/See beginning in the seventh year at a rate of 10 percent per year. Your planning period (N) = 10 years. Thus the BEQIMP(i) • MESL(i) costs over 10 years are

Year	1	2	3	4	5	6	7	8	9	10
BEQIMP(i) • MESL(i)	14300	0	0	0	0	0	1300	1300	1300	1300

BEMQCI(i) = total cost of institutional base training equipment maintenance in year i

= BCOPMT(i) • SI(i) + BOMFEQ(i)

EXAMPLE:

The TASO advises you that maintenance for fielded Cue/See will cost $10 per unit for the first six years and $40 per unit per year after six years. Thus for years 1-6 the cost is 22 $10 = $220. Starting in the seventh year 10 percent of the units (22 • .10 = 2) will be replaced each year so maintenance cost will be (20 • $40 + 2 • $10 = $820) for year seven. The N=10 year matrix is as shown.

Year	1	2	3	4	5	6	7	8	9	10
BCOPMT(i) • SI(i)	220	220	220	220	220	220	820	760	700	640

The maintenance costs for the projectors are reported as $20 per year for both or $200 for the 10-year period, prorated for this task is $200 x .25 = $50.

TRADOC Reg 11-5

COST AND ANALYSIS PROGRAM (MOS Training Costs) (TRADOC Reg 11-5)	TRADOC EQUIPMENT DATA ☐ ATC ☐ School (check one)	Fiscal Year	REQUIREMENTS CONTROL SYMBOL ATRA-1510-R1 Page of Pages
Name location of ATC or School		Function/Org	Total Equip Acq Cost

LINE	Course Number a	Acquisition Value b	(leave blank) c

NOTE: The acquisition value of equipment should not be identified by course unless that piece of equipment can be positively identified as supporting only one course.

TRADOC FORM 811-R 8 x 10½

Figure 3.

RESOURCE SUMMARY FY_____

(TRADOC Cir 351-3)

MOS	Program Element For: Training Development
Training Location	Implementation

			a. Total Requirement			b. Available from Current ITP			c. Available From School Assets			d. Shortfall		
ANALYSIS	MP	Mil	Off	WO	EM	Off	WO	EM	Off	WO	EM	Off	WO	EM
		Civ	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY
	EOE BY CODE													
	Total $													
DESIGN	MP	Mil	Off	WO	EM	Off	WO	EM	Off	WO	EM	Off	WO	EM
		Civ	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY
	EOE BY CODE													
	Total $													
DEVELOPMENT	MP	Mil	Off	WO	EM	Off	WO	EM	Off	WO	EM	Off	WO	EM
		Civ	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY
	EOE BY CODE													
	Total $													
IMPLEMENTATION	MP	Mil	Off	WO	EM	Off	WO	EM	Off	WO	EM	Off	WO	EM
		Civ	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY
	EOE BY CODE													
	Total $													
EVALUATION	MP	Mil	Off	WO	EM	Off	WO	EM	Off	WO	EM	Off	WO	EM
		Civ	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY	ES	FTP	MY
	EOE BY CODE													
	Total $													

TRADOC Form No. 125-R

Figure 4.

BCOPMT(i) = cost per student of maintenance of variable-cost institutional base training equipment in year i. The TASO may have data that will help with this variable as may PM TRADE.

BOMFEQ(i) = cost of operation and maintenance of fixed-cost institutional base training equipment in year i. The TASO may be able to furnish data on this variable as may PM TRADE.

SI(i) = average number of students $\left(\frac{\text{total input + total output}}{2}\right)$ in institutional training for this system in year i.

BACIMD(i) = BCIMD • R • MESL(i) (4.14)

where

BCIMD = cost per student in year i for instructional material development. See TRADOC Form 858-R, TRADOC Schools Mission Data by Function/Organization (Figure 5) submitted in accordance with TRADOC Reg 11-5.

R = number of repetitions of the course in year i (assumed constant).

BAIMMC(i) = BCUIMD • SI(i) (4.15)

where

BCUIMD = average annual cost per student for maintenance of instructional material. (This cost is assumed constant but could be made variable on a yearly basis by inserting the appropriate yearly value where used.) The Management Analysis Division or DTD should have experience factors.

BSUPPY(i) = BSUPLY(i) • SI(i) (4.16)

where

BSUPLY(i) = cost per student of institutional base supplies consumed in year i. See TRADOC Form 858-R (Figure 4), TRADOC Schools Mission Data by Function/Organization submitted in accordance with TRADOC Reg 11-5.

BCINST(i) = [BPALIN(i) • BINSTR • MESL(i) + BOVERH(i) • BRORAT(i) • SI(i)] • BTIME (4.17)

where

BPALIN(i) = average annual pay and allowances of an instructor in institutional base training in year i. Compute this in accordance with Section III, TRADOC Resources Factors Handbook.

BACIMD(i) = total cost of institutional instructional material development in year i.

= BCIMD • MESL(i) • R

EXAMPLE:

DTD has developed the following data on the system course as input to TRADOC Form 858-R, TRADOC Schools Mission Data by Function/Organization.

For training this particular task, three (3) TEC lessons will be developed at a cost of $12,000 per lesson. Reproduction costs will be $3000.

DTD has determined that manpower costs for instructional material development for the course = $192,000. This task's pro rata share = .25 • 192,000 = $48,000.

Notwithstanding the equation given above, these data lend themselves to direct computation of BACIMD(i) as follows:

BACIMD(i) = (3 • 12,000) + 3000 + 48,000

= $87000 = $87 (thousands)

BAIMMC(i) = total cost of institutional instructional material in year i

= BCUIMD • SI(i)

EXAMPLE:

DTD informs you that they use a factor of 20 percent of the development costs to compute maintenance costs for instructional materials. Again, it is easier to compute BAIMMC(i) directly without having to use the equation.

BAIMMC(i) = .20 • 87000 = $17.4 (thousands)

BSUPPY(i) = total cost of supplies consumed in year i in institutional base training

= BSUPLY(i) • SI(i)

EXAMPLE:

You ask the Director of Instruction how he computed the entry for column c of TRADOC Form 858-R. You find his input for base supplies was based on $3.00 per student for the course you are interested in. The average number of students $\left(\frac{\text{total input + total output}}{2}\right)$ trained on the system during year i = 200. Again, note this task takes 25 percent of the total training time.

BSUPPY(i) = $3.00 • 200 • .25 = 150 = .2 (thousands)

BCINST(i) = total cost of pay and allowances of all instructors in institutional instructional base training in year i

= [BPALIN(i) • BINSTR • MESL(i) + BOVERH(i) • BRORAT(i) • SI(i)] • BTIME

EXAMPLE:

In order to compute BPALIN(i) (average annual pay and allowances of an instructor in institutional base training in year i), you obtain the latest military (and civilian, if needed) pay scales. You obtain from the Department of Instruction the numbers of instructors by grade who will train the task. By using the methodology on page 35 in Section III of the TRADOC Resource Factor Handbook (7 December 1978), you determine the average pay and allowances of an instructor is $19,400 = $19.4 (thousands). You have determined earlier the BINSTR for this task is .1. The Department of Instruction indicates that the student input for year i will be 22259. You see from TRADOC Form 858-R, lines 6, 7, and 8 and column f that total overhead expenses are $3,059,700. By dividing this by number of students the overhead per student = $137.46 = BOVERH(i). BRORAT(i) = ratio of average number of students training on this task in year i to total number of students in institutional base training in year i = $\frac{200}{22259}$ = .009.

The system course is 4 weeks, of which 3 weeks are base training and one week is field training. There are 12 repetitions of the course per year.

BTIME = $\frac{36}{48}$ = .75

BCINST(i) = [(.1 • 19440 • 20) + (137.46 • .009 • 200)] • .75 • .25 = (38880 + 247.49) • .75 • .25 = 7336 = $7.3 (thousands)

COST ANALYSIS PROGRAM (MOS Training Costs) (TRADOC Reg 11-5)	TRADOC SCHOOLS MISSION DATA BY FUNCTION/ORGANIZATION Name/location of School	Fiscal Year	REQUIREMENTS CONTROL SYMBOL: ATRM-159(R1) Page 1 of 2 Pages

LINE	Function/Org Element	Total Expenses				Total OMA Expenses	MPA	Military Man-Years Assigned	Civilian Man-Years Assigned
	a	Civ Pay & Allowances 110 & 120 b	Supplies & Equip 260 & 310 c	TDY 210 d	Svc & Other 220 thru 250 e	f	g	h	i
	Program 8 Training								
1	Combat Dev (PE 819725.1 or .2)								
2	Tng Spt to Units (PE 819731.1)								
3	Tng Dev (PE 814772.1, .2, or .4)								
4	School/Institute/College (PE 8147XX)								
5	Overhead								
6	Command Group								
7	Directorate of Support								
8	Directorate of Evaluation								
9	Other (List)								
10									
11									
12									
13	Dir of Tng (Less Res Tng Dept)								
14	Resident Training Dept (List each)								
15									
16									
17									
18									
19									
20									
21	School Brigade 1/								
22	COI Crs Support								
23	Army Subject Schedule Support								
24	Other PE 8147XX Elements								
25	FMS/TMET Information Prog 2/								
26	OCS (814722)								
27	Tng Spt Division (814771.3) 3/								
28	Other (List) 4/								
29									
30	OSUT (PE 814761)								
31	OSUT BDE/BN								
32	Committee Group								
33	Organizational Clo & Equip								
34	Other (List)								
35									
36									

TRADOC FORM 858-R Previous editions are obsolete. 30% = 8

TRAINT Reg 11-5

Figure 5.

TRADOC SCHOOLS MISSION DATA BY FUNCTION/ORGANIZATION (Continued) RCS ATRM-159(R1) Page 2 of 2 Pages

LINE	Function/Org Element a	Total Expenses: Civ Pay & Allowances 110 & 120 b	Supplies & Equip 260 & 310 c	TDY 210 d	Svc & Other 220 thru 250 e	Total OMA Expenses f	MPA g	Military Man-Years Assigned h	Civilian Man-Years Assigned i
	Other Program Elements (List)								
	Org Clo & Equip (School Share) 5/								
	Individual Clo (School Share) 5/								
	P8 School Troops (List each unit)								
	P2/P3 TOE Spt (List each unit)								
	Flt Tng Costs (other than P8T)								

REMARKS

NOTES: 1/ Costs associated with School Brigade/Battalion should be identified to two categories; support of COI courses and support of Army Subject Schedule courses, when separate brigades or battalions can be identified.

2/ Attach a listing of FMS/IMET courses for which the Information Program is conducted. (Not required if Information Program costs are identified on Figure C-2.)

3/ Normally the Training Support Division will exist only on non-TRADOC installations.

4/ Identify other 8147XX Function which contribute significantly to resident training (Exception: Do not include student TDY (81471.1 & .2)).

5/ Report only that portion which can be identified to resident training.

TRADOC Pam 11-5

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BOVERH(i) = cost per student of institutional base operations overhead in year i. These data may be available from the TRADOC Form 858-R, TRADOC Schools Mission Data by Function/Organization (Figure 5), submitted in accordance with TRADOC Reg 11-5. Also check the Center/School Management Analysis Division or Program and Budget Division or other office responsible for these functions.

BRORAT(i) = Ratio of average number of students in initial training on the particular system to average total number of students in institutional base training in year i.

BTIME = fraction of year spent by each student in institutional base training.

$$BPALST(i) = ASTUPA(i) \bullet BTIME \bullet SI(i) \qquad (4.18)$$

where

ASTUPA = average annual pay and allowances of students in year i. Compute this in accordance with Section III, TRADOC Resources Factor Handbook.

$$BTRANS(i) = BTRAVL(i) \bullet SI(i) + BEQTRS(i) \qquad (4.19)$$

where

BTRAVL(i) = cost per student for travel (including per diem) in connection with institutional base training in year i. Compute this in accordance with Section III, TRADOC Resources Factor Handbook. May also be obtained from inputs to column d of TRADOC Form 858-R.

BEQTRS(i) = cost for transportation of equipment used in institutional base training in year i. Compute this in accordance with Section III, TRADOC Resources Factor Handbook.

$$BRVAST = \sum_{i=1}^{N} [BFACOS(i)] \bullet [1-(FAD)\ (N-i+1] + [BEAQCI(i)] \bullet [1-(EAD)\ (N-i+1] + [BACIMD(i)] \bullet [1-(IAD)\ (N-i+1)] \qquad (4.2)$$

where

FAD = annual depreciation rate of facilities (assumes straight-line depreciation). The DIO should be able to give you the depreciation rate.

BPALST(i) = total cost of pay and allowances of students in institutional base training in year i

= ASTUPA(i) • SI(i) • BTIME

EXAMPLE:

The Office of Management gives you a breakdown of numbers of students by grade of students training on the system per year. By using page 35 in Section III of TRADOC Resource Factor Handbook (7 December 1979), you determine the average pay and allowances of a student (ASTUPA(i)) is $10,128. The system course is four weeks of which 3 are base training.

$$BPALST(i) = 10128 \bullet 200 \bullet \frac{3}{4} \bullet .25 = \$379,800 = \$379.8 \text{ (thousands)}$$

BTRANS(i) = total cost of travel (including per diem) and equipment transportation in connection with institutional training in year i

= BTRAVL(i) • SI(i) + BEQTRS(i)

EXAMPLE:

The Office of Management tells you that the average one way mileage used for cost estimation for the course is 700. Using Section III (page 48) of the TRADOC Resource Factor Handbook, you find the factor for air travel is $.1176.

BTRAVL(i) = .1176 • 700 = 82.32

BTRAVL(i) • SI(i) • .25 = 82.32 • 200.25 = 44,116

You will have to compute costs for 1/2 ton of Besseler Cue/See and tapes from the depot -- a distance of 1000 miles. Again using Section III (page 48) of TRADOC Resource Factor Handbook.

BEQTRS(i) = .5 • .0568 • 1000 = $28.40

BTRANS(i) = $4,116 + $28.40

BTRANS(i) = $4.1 (thousands)

BRVAST = remaining value of facilities, equipment, and instructional materials at end of planning period (N years)

$$= \sum_{i=1}^{N} [BFACOS(i)] \bullet [1-(FAD)(N-i+1)] + [BEAQCI(i)] \bullet [1-(EAD)(N-i+1)] + [BACIMD(i)] \bullet [1-(IAD)(N-i+1)]$$

EXAMPLE:

The DIO informs you that the two maintenance sheds that will be used for the course are fully depreciated. You set FAD as 1 (100%). Therefore [BFACOS(i)] • [1-(FAD)(N-i+1)] = 0.

The TASO recommends a ten percent depreciation rate be used for the combined Cue/See and 35 mm projectors. Thus, EAD = .10.

DTD tells you they do not intend to revise the TEC lessons during the planning period. The TASO suggests a 10 percent depreciation rate on the tapes. Thus, IAD = .10.

EAD = annual depreciation rate of equipment (assumes straight-line depreciation). The DIO and/or the TASO (for training aids) should be able to furnish these data. The Audio-Visual Equipment Directory will also give data on useful life of such equipment.

IAD = annual depreciation rate of instructional materials (assumes straight-line depreciation). The following table* can be used to derive the depreciation rate depending on the type of instructional materials.

Courseware Type	Estimated Useful Life (In Years)
Videotape	1 to 5 years depending on use
Audiotape	1 to 10 years depending on use
Film	2 to 5 years depending on use
Filmstrip	Unknown
Photos	Indefinite
Slides	Indefinite
Transparencies	Indefinite
Printed material	Indefinite
Charts, maps	Indefinite
Microfiche	Indefinite
Microfilm	Unknown
Record	1 to 5 years depending on use

Turning to the field training conducted at the institution:

$$FVALUE = \sum_{i=1}^{N} \frac{FDCAST(i)}{(i+d)^{(i-1)}} - \frac{FRVAST}{(1+d)^{N}} \qquad (5)$$

where

FDCAST(i) = total non-discounted cost of institutional field training in year i, and

FRVAST = remaining value of equipment and instructional materials used in institutional field training at end of planning period.

$$FDACST(i) = FEAQCI(i) + FEMQCI(i) + FSUPPY(I) + FCINST(i) + FPALST(i) + FPATRS(i) + FTRANS(i) \qquad (5.1)$$

*From Hess and Kantar, MODIA: Vol. 5, A User's Guide to the Cost Model.

where

FEAQCI(i) = total cost of acquisition in year i of equipment required for institutional field training,

FEMQCI(i) = total cost in year i of operation and maintenance of equipment required for institutional field training,

FSUPPY(i) = total cost of supplies consumed in year i in institutional field training,

FCINST(i) = total cost of pay and allowances in year i of instructors of institutional field training, and

FPALST(i) = total cost of pay and allowances in year i of students in institutional field training.

FPATRS(i) = total cost of pay and allowances of troop support (P8 or P2) in year i for institutional field training.

FTRANS(i) = total cost of transportation in year i for equipment and material used in institutional field training.

These variables are further defined as follows:

$$FEAQCI(i) = FEQIMP(i) \bullet SI(i) + FEQCIS(i) + FEQTRS(i) \qquad (5.11)$$

where

FEQIMP(i) = cost per student of variable-cost institutional field training equipment that must be acquired in year i. See data source comment for BEQIMP(i).

FEQCIS(i) = total cost of fixed-cost institutional field training equipment acquired in year i. See data source comment for BEQCIS(i).

FEQTRS(i) = total cost of equipment of troop support units attributable to training this task.

$$FEMQCI(i) = FCOPMT(I) \bullet SI(i) + FOMFEQ(i) + FOMTRS(i) \qquad (5.12)$$

where

FCOPMT(i) = cost per student of maintenance of variable-cost institutional field training equipment in year i. See data source comment for BCOPMT.

FOMFEQ(i) = cost of operation and maintenance of fixed-cost institutional field training equipment. See data source comment for BOMFEQ.

FOMTRS(i) = cost of operation and maintenance of troop support equipment attributable to training this task.

FEAQCI(i) = total cost of acquisition in year i of equipment required for institutional field training

= FEQIMP(i) • SI(i) + FEQCIS(i) + FEQTRS(i)

EXAMPLE:

Although no equipment for field training of this task must be acquired, DTD tells you that one week of the four week course will be field training on equipment and with troops of a school troop (P8) battery. You see from TRADOC Form 858-R (column C) that the total value of equipment on hand in the battery is $51,000. As previously determined, training this task represents .25 of the training time on the system. Field training represents .25 of course time and 1 week - 48 weeks of the school year. There are 12 repetitions of the course during the year. Thus,

$$FEQTRS(i) = 51{,}000 \bullet \frac{1}{48} \bullet .25 \bullet 12 = \$3187.50$$

FEAQCI(i) = $3.2 (thousands)

FEMQCI(i) = total cost in year i of operation and maintenance of equipment required for institutional field training

$$= [FCOPMT(i)] \bullet SI(i) + FOMFEQ(i) + FOMTRS(i)$$

EXAMPLE:

The battery of school troops (P8) tells you that the battalion is using a figure of $2500 per year for operation and maintenance of the battery equipment. Thus,

$$FEMQCI(i) = \$2500 \bullet \frac{12}{48} \bullet .25 = \$156.25 = \$.2 \text{ (thousands)}$$

$$FSUPPY(i) = [FPETRO(i) + FAMMO(i) + FCONSU(i)] \bullet SI(i) \quad (5.13)$$

where

FPETRO(i) = cost per student of petroleum products (POL) consumed in institutional field training in year i. The DIO should have data on this item.

FAMMO(i) = cost per student of ammunition expended in institutional field training in year i. See TRADOC Form 810-R, TRADOC Ammunition Costs (Figure 6) submitted in accordance with TRADOC Reg 11-5 and the Training Ammunition Management Information System (TAMIS).

FCONSU(i) = cost per student of miscellaneous consumables consumed in institutional field training in year i. See data source comment for BSUPLY(i).

$$FCINST(i) = FPALIN(i) \bullet FINSTR \bullet FTIME \bullet MESL(i) \quad (5.14)$$

where

FPALIN(i) = average annual pay and allowances of an instructor in institutional field training in year i. Compute these in accordance with Section III, TRADOC Resources Factor Handbook.

FTIME = fraction of year spent by each student in institutional field training.

$$FPALST(i) = ASTUPA(i) \bullet FTIME \bullet SI(i) \quad (5.15)$$

$$FPATRS(i) = APATRS(i) \bullet FTIME \quad (5.16)$$

where

APATRS = annual pay and allowances of troop support (P8 or P2) P2 unit costs are incurred whether the unit trains or not or assists in training or not. Nevertheless, in costing alternative training programs, it may be useful to include these costs where they differ significantly among alternatives. You may find troop support personnel costs in column g of TRADOC Form 858-R or from the unit or compute them using Section III of TRADOC Resource Factor Handbook.

$$FRVAST = \sum_{i=1}^{N} [FEAQCI(i)] \bullet [1-(EAD)(N-i+1)] \quad (5.2)$$

Turning to the training conducted in the Program 2 units (only if the task is not trained to proficiency in the institution).

FSUPPY(i) = total cost of supplies consumed in year i in institutional field training

= [FPETRO(i) + FAMMO(i) + FCONSU(i)] • SI(i)

EXAMPLE:

The battery tells you that it costs $140 per day for POL to get to and from the range and operate for the day on the range.

FPETRO(i) • SI(i) = 5 • 140 • 12 • .25 = $2100 = $2.1 (thousands)

TRADOC Form 810-R (TRADOC Reg 11-5) lists ammunition costs for the course and for the year at $100,000. Thus,

FAMMO(i) • SI(i) = 100,000 • .25 = 25,000 = $25.0 (thousands)

The battery tells you that they use a personnel cost factor of $1.00 per man per day in the field for consumable supplies. There are 90 men in the battery.

FCONSU(i) • SI(i) = (90 • 5 • 12 • $1.00 • .25) + (200 • 5 • $1.00 • .25) = 1350 + 250 = 1600 = $1.6 (thousands)

FSUPPY(i) = $2100 + 25,000 + 1600 = 28700 = $28.7 (thousands)

FCINST(i) = total cost of pay and allowances in year i of instructors of institutional field training

= FPALIN(i) • FINSTR • FTIME • MESL(i)

EXAMPLE:

The same instructors that train in base training will train in the field (with the assistance of the school troop battery). The average pay and allowances of these instructors was determined previously to be $19,440. The same instructor/student ratio of .1 holds. Time in the field has been determined to be $\frac{12}{48}$ = .25 = FTIME

FCINST(i) = 19,400 • .1 • .25 • 20 • .25 = $243 = $.2 (thousands)

FPALST(i) = total cost of pay and allowances in year i of students in institutional field training

= ASTUPA • FTIME • SI

EXAMPLE:

Average student pay and allowances was determined as $10,128.

$$FPALST(i) = 10,128 \bullet \frac{1}{48} \bullet 200 \bullet .25 = 10550 = \$10.6 \text{ (thousands)}$$

FPATRS(i) = total cost of pay and allowances of troop support (P8 or P2) in year i for institutional field training.

= APATRS(i) • FTIME

EXAMPLE:

From TRADOC Form 858-R (column g) you find the annual MPA costs of the battery are $850,000

$$FPATRS(i) = 850,000 \bullet \frac{12}{48} \bullet .25 = \$53,125 = \$53.1 \text{ (thousands)}$$

FTRANS(i) = total cost of transportation of equipment and ammunition for institutional field training in year i

EXAMPLE:

The DIO informs you that the ammunition for the course would have a shipping weight of 5 tons. In Section III of TRADOC Resource Factor Handbook you find a factor of .0691. The DIO also tells you that the distance the ammunition is shipped is 750 miles.

FTRANS(i) = 5 • .0691 • 750 • .25 = $64.78 = $0.1 (thousands)

which can be disregarded as insignificant.

FRVAST(i) = remaining value of equipment and instructional materials used in institutional field training at end of planning period

$$= \sum_{i=1}^{N} [FEAQCI(i)] \bullet [1-(EAD)(N-i+1)]$$

EXAMPLE:

You have determined FEAQCI(i) to be $3.2 (thousands) and EAD to be .10.

COST AND ANALYSIS PROGRAM (MOS Training Costs) (TRADOC Reg 11-5)	TRADOC AMMUNITION COSTS ☐ ATC ☐ School (check one)	Fiscal Year	REQUIREMENTS CONTROL SYMBOL ATRM-159(R1) Page of Pages

Name/location of ATC or School

LINE	Course Number a	Ammunition Costs b	(leave blank) c

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8 x 10½

Figure 6.

$$UVALUE = \sum_{n=1}^{N} \frac{UDACST(i)}{(i+d)^{(i-1)}} - \frac{URVAST}{(1+d)^{N}} \qquad (6)$$

where

UDACST(i) = total non-discounted cost of unit training in year i,

URVAST = remaining value of facilities and equipment used in in unit training at end of planning period (N years).

UDACST(i) = UFACOS(i) + UFMCOS(i) + UEAQCI(i) + UEMQCI(i)

+ USUPPY(i) + UCTNR(i) + UCTNE(i) + UTRANS(i) (6.1)

where

UFACOS(i) = total cost of unit training facilities acquisition in year i. See comments for BFACOS(i). With respect to unit training facilities, an example would be the Moving Target Simulator (MTS) facilities operated by USA Garrisons at various locations to train REDEYE tracking. "Basis of issue" and estimated cost data should be available from Department of Training Development (DTD) and/or the Department of Combat Developments (DCD). Another possible source is the office of the Program/Project/Product Manager (PM).

UFMCOS(i) = total cost of unit maintenance of training facilities in year i.

UEAQCI(i) = total cost of unit training equipment acquisition in year i.

UEMQCI(i) = total cost of unit training equipment maintenance in year i.

USUPPY(i) = total cost of supplies consumed in unit training in year i.

UCTNR(i) = total cost of pay and allowances of all trainers in unit training in year i.

UCTNE(i) = total cost of pay and allowances of trainees in unit training in year i, and

UTRANS(i) = total cost of travel (including per diem) and equipment transportation in connection with unit training in year i.

The variables in Equation 6.1 are further defined as follows:

UFMCOS(i) = UTSQFT(i) • UCSQFT(i) (6.11)

UFACOS(i) = total cost of unit training facilities acquisition in year i

EXAMPLE:

Let us assume for illustrative purposes that each of ten units requires a special range to train the system. Let us assume further that the task is not trained to proficiency in the institution. (If the task is trained to proficiency in the institution, by our definitions, UVALUE = 0). Task training continues to represent 25 percent of total system training. It is estimated that each such P2 unit will have to train an average of 16 trainees per year on the system. Assume further that the acquisition cost of each range is $10,000 (which can be obtained from the DIO).

An average of estimates from the units indicates that it will take two weeks on the range to bring each school graduate to proficiency (but two such students can use the range concurrently). At other times the range will be used for refresher training (not to be costed) during a 50 week training year.

$$UFACOS(i) = 10{,}000 \bullet .25 \bullet \frac{16}{50} \bullet 10 = \$8{,}000 = \$8 \text{ (thousands)}$$

UFMCOS(i) = total cost of unit maintenance of training facilities in year i

= UTSQFT(i) • UCSQFT(i)

EXAMPLE:

The Director of Facilities Engineering informs you that an average cost of maintaining the special ranges would be $500 per year.

$$UFMCOS(i) = 500 \bullet 10 \bullet .25 \bullet \frac{16}{50} = \$400 = \$.4 \text{ (thousands)}$$

where

UTSQFT(i) = total square feet of unit training facilities required in year i to train the particular task or system. Refer to MTS example above or special ranges required for this task or system. See comments for UFACOS(i).

UCSQFT(i) = cost per square foot of operation and maintenance of unit training facilities in year i. See source data comment for BCSQFT(i). The PM or TRADOC System Manager (TSM) are also potential data sources.

$$UTSQFT(i) = [USQFTE + UTNRE \bullet USQFTR] \bullet METL(i) + USQFTA \qquad (6.111)$$

where

USQFTE = square feet per trainee of unit training facilities (assumed constant). See source data comments for UFACOS(i).

UTNRE = trainer to trainee ratio in unit training (assumed constant).

USQFTR = square feet of unit training facilities per trainer (assumed constant). See source data comments for UFACOS(i).

METL = maximum expected trainee load.

USQFTA = square feet of administrative facility space required to support unit training on the particular system being studied. If the space would be required even if the system were not being trained, this variable will be zero. See source data comments for UFACOS(i).

$$UEAQCI(i) = UEQIMP(i) \bullet TU(i) + UEQCIS(i) \qquad (6.12)$$

where

UEQIMP(i) = cost per trainee of variable-cost equipment used in unit training in year i. Potential data sources are DTD, DCD, appropriate PM, TSM, or PM TRADE. For fielded equipment, costs can be computed from SB-700-20.

UEQCIS(i) = cost of fixed-cost equipment acquired for unit training in year i. See comments for UEQIMP above.

TU(i) = number of trainees in unit training in year i.

$$UEMQCI(i) = UCOPMT(i) \bullet TU(i) + UOMFEQ(i) \qquad (6.13)$$

where

UEAQCI(i) = total cost of unit training equipment acquisition in year i

= UEQIMP(i) • TU(i) + UEQCIS(i)

EXAMPLE:

Since no equipment is required solely for training to initial proficiency, UEAQCI(i) = 0 in this case. Although the unit may be armed with the system, the cost of the system is properly chargeable to the operational requirements of the unit. The cost of the equipment would be the same even if there were no training. Because UEAQCI(i) = 0, UEMQCI also is zero.

UCOPMT(i) = cost per trainee of maintenance of variable-cost unit training equipment in year i. Potential data sources are PM, TSM, PM TRADE, TA50.

UOMFEQ(i) = cost of operation and maintenance of fixed-cost unit training equipment in year i. See comments for UCOPMT(i) above.

$$USUPPY(i) = [UPETRO(i) + UAMMO(i) + UCONSU(i)] \cdot TU(i) \quad (6.14)$$

where

UPETRO(i) = cost per trainee of petroleum products (POL) consumed in year i. Each major unit has developed consumption factors for unit-miles per gallon and vehicle-miles per gallon for both MOGAS and diesel as well as consumption per day for generators, stoves, etc. Data are also available for "unit day in the field" that combines these consumption figures. The FORSCOM training management control system (TMCS) and USAREUR control of logistic expenditure (COLEX) present such operating cost factors. Latest cost per gallon for MOGAS and diesel can be obtained from the Defense Fuel Supply Center.

UAMMO = cost per trainee of ammunition expended in unit training in year i. TC 25-3, *Training Ammunition*, may be used as a guide. Costs can be computed from SB-700-20 and TAMIS for standard ammunition. For developing systems, check PM, TSM.

UCONSU(i) = cost per trainee of miscellaneous consumables consumed in unit training in year i. Use "unit day in the field" factor by type unit. Major cost item generally is spare parts and this will be included in the factor.

$$UCTNR(i) = UPATNR(i) \cdot UTNRE \cdot UTIME \cdot TU(i) \quad (6.15)$$

where

UPATNR(i) = average annual pay and allowances of a trainer in unit training in year i. Compute in accordance with Section III, TRADOC Resource Factor Handbook.

UTIME = fraction of year spent by each trainee in unit training.

$$UCTNE = UPATNE(i) \cdot UTIME \cdot TU(i) \quad (6.16)$$

where

UPATNE(i) = average annual pay and allowances of trainees in unit training in year i. Compute in accordance with Section III, TRADOC Resource Factor Handbook.

USUPPY(i) = total cost of supplies consumed in unit training in year i

= [UPETRO(i) + UAMMO(i) + UCONSU(i)] • TU(i)

EXAMPLE:

"Unit day in the field" data from several batteries average $150 per day for a battery to go to and from the ranges and to operate per day in the field. There are 90 men total in each of ten such batteries.

$$UPETRO(i) \bullet TU(i) = 150 \bullet 10 \bullet 5 \bullet 2 \bullet .25 \bullet \frac{16}{90} = \$667 = \$.7 \text{ (thousands)}$$

Queries to the G-3 (Training) of the different divisions involved indicate an average of five rounds per trainee for proficiency training on the system and a cost of $50 per round.

$$UAMMO(i) \bullet TU(i) = \$50 \bullet 5 \bullet .25 \bullet 16 \bullet 10 = \$10,000 = \$10 \text{ (thousands)}$$

"Unit day in the field" data from several batteries average $1.30 per man per day in the field for consumable supplies (includes spare parts).

$$UCONSU(i) \bullet TU(i) = \$1.30 \bullet 10 \bullet 5 \bullet 2 \bullet .25 \bullet 16 = \$520 = \$.5 \text{ (thousands)}$$

USUPPY = $667 + 10,000 + 520 = $11,187 = $11.2 (thousands)

UCTNR = total cost of pay and allowances of all trainers in unit training in year i

= UPATNR(i) • UTNRE • UTIME • TU(i)

EXAMPLE:

You determine from the procedures in Section III, TRADOC Resource Factor Handbook that the average pay and allowances (UPATNR(i)) of a trainer for the system = $14,000. The ratio of trainers to trainees for initial proficiency training = 1:2 = UTNRE. Each trainee will spend two weeks of the 50 week training year in completing his initial proficiency training (UTIME) = 2 ÷ 50. There will be 16 such trainees. The task training will take 25 percent of the system training time. Thus,

$$UCTNR = \$14,000 \bullet \frac{1}{2} \bullet \frac{2}{50} \bullet 16 \bullet 10 \bullet .25 = \$11,200 =$$

$11.2 (thousands)

UCTNE(i) = total cost of pay and allowances of trainees in unit training in year i

= UPATNE(i) • UTIME • TU(i)

EXAMPLE:

Using the procedures in Section III, TRADOC Resource Factor Handbook, you determine the average pay and allowances of a trainee (UPATNE(i)) = $10,128. You have already determined:

UTIME = $\frac{2}{50}$,

TU(i) = 16,

UCTNE(i) = $10,128 • $\frac{2}{50}$ • 16 • 10 • .25 = $16200 =

$16.2 (thousands)

$$UTRANS(i) = UTRAVL(i) \bullet TU(i) + UEQTRS(i) \qquad (6.17)$$

where

UTRAVL(i) = cost per trainee for travel (including per diem) in connection with unit training in year i. Compute in accordance with Section III, TRADOC Resources Factor Handbook.

UEQTRS(i) = cost for transportation of equipment used in unit training in year i. Compute in accordance with Section III, TRADOC Resource Factor Handbook.

$$URVAST = \sum_{i=1}^{N} [UFACOS(i)] \bullet [1-(FAD)(N-i+1)] + [UEAQCI(i)] \bullet [1-(EAD)(N-i+1)] \qquad (6.2)$$

Having determined the total cost to train each individual task to initial proficiency, the cost of the total training program may be determined as follows:

$$TPROGR = \sum_{j=1}^{M} TVALUE_j \qquad (7)$$

where M = number of tasks contained in the program.

As a convenience to the reader, all of the foregoing equations are presented sequentially without text in Appendix 2 to Annex D.

As a further convenience, a matrix of variables versus potential data sources is at Appendix 3 to Annex D.

UTRANS(i) = total cost of travel (including per diem) and equipment transportation in connection with unit training in year i

= [UTRAVL(i)] • TU(i) • UEQTRS(i)

EXAMPLE:

Since there is no trainee travel involved in this case, UTRAVL(i) = 0. DIO informs you that ammunition to be used for initial proficiency training has a shipping weight of one ton and the shipping distance averages 500 miles for all ten units. The factor from Section III, TRADOC Resource Factor Handbook = .0691.

UEQTRS(i) = 1 • .0691 • 500 • 10 • .25

= 86.38

= 0.1 (thousands)

which can be disregarded as insignificant.

URVAST = remaining value of facilities and equipment used in unit training at end of planning period (N year)

$$= \sum_{i=1}^{N} [UFACOS(i)] \bullet [1-(FAD)(N-i+1)] + [UEAQCI(i) \bullet [1-(EAD)(N-i+1)]$$

EXAMPLE:

You have determined that:

UFACOS(i) = $12,000

UEAQCI(i) = 0

FAD = .10

E. Comparison of Training Program Alternatives

1. TEEM

Having determined the effectiveness of two or more alternatives by computing their efficiency ratios (see paragraph C1 above), compare the alternatives on the basis of these efficiency ratios and the cost of the alternatives. In order to help you avoid dealing with very large numbers when you form cost/effectiveness ratios, you may want to normalize the costs of the alternatives. (This can be done simply by dividing the cost of each alternative by the cost of the lowest cost alternative. Note that the normalized cost of the lowest cost alternative becomes 1. The relationship among the costs remains the same, but the ratios are more manageable.)

2. TCA

The basis for this process method has been established by the procedures given in paragraph C5 (TCA). The output information derived from those procedures are needed for this procedure.

Step 1. Assemble the TCA output information derived from Process Method C as shown in the example in Table III-16. Arrange task information by task group and also include, if applicable, group statistics.

Step 2. Compare alternative training programs by TCRs of tasks, of task groups, and of all tasks (the overall TCR). Tentatively select the alternative with the highest overall TCR.

Step 3. Compare alternatives task by task. Compare alternative deficiencies, excesses, and redundancies, and if one alternative is an actual program while others are only descriptions, decide if revision of the actual program can be recommended on this basis.

Step 4. Eliminate from consideration training program alternatives with unacceptable TCRs.

Step 5. With cost estimates from Process Method III-D, form a C/E ratio for each remaining alternative (cost/TCR). Choose the alternative with the lowest or lower C/E value.

3. BDM/CARAF*

This method of comparison of training program alternatives assumes that you have comparable effectiveness data for the alternatives you are comparing and that you have cost data from which you can derive the life cycle cost per unit.

a. Complete the training system data matrix by first assigning a weight to each of the measures of training effectiveness (MOTEs) selected. Assign weights between "1" and "99", and they should indicate your judgment as

*Adapted from BDM Services Company, Cost and Training Effectiveness Analysis (CTEA) Handbook for Action Offices, 15 January 1976.

Table III-16. TCA Output Data
(adapted from Hawley and Thomason, 1978)

	DEFICIENCIES			EXCESSES			REDUNDANCIES			TRAINING CONSONANCE RATIO		
ALTERNATIVE	A	B	C	A	B	C	A	B	C	A	B	C
TASK NUMBER												
5804	2	10	11	47	22	8	30	15	2	.933	.667	.633
6100	1	9	10	48	22	9	30	16	2	.964	.679	.643
6701	10	10	11	10	10	2	21	21	2	.722	.722	.694
6702	8	8	8	22	22	6	14	14	2	.724	.724	.724
6703	12	12	12	19	19	5	16	16	2	.647	.647	.647
6801	13	13	14	21	21	7	15	15	2	.618	.618	.588
6802	13	13	13	24	24	8	14	14	2	.594	.594	.594
6900	12	12	12	27	27	9	12	12	2	.600	.600	.600
7000	11	11	11	24	24	8	14	14	2	.633	.633	.633
7700	6	17	18	42	21	9	32	16	1	.838	.541	.514
										OVERALL T.C.R.		
										.917	.650	.599

to the relative worth of the MOTEs. Usually weights between 50 and 90 will be most satisfactory. If a MOTE has little impact upon the overall effectiveness of the system, reconsider the need for the MOTE. Further, if a MOTE has a weight of 100, you would not need to have other MOTEs. Use you best judgment. For example:

	$MOTE_1$	$MOTE_2$	$MOTE_3$	$MOTE_4$	ΣE	
WEIGHTS→	90	50				
BASE CASE						← E_B
A_1						← E_{A_1}
A_2						← E_{A_2}
A_3						← E_{A_3}

b. Determine the MOTE data values for the base case and each of the alternative systems as shown below. Document the sources of data. If no data are available, document this fact also.

	$MOTE_1$	$MOTE_2$	$MOTE_3$	$MOTE_4$	ΣE	
WEIGHTS→	90	50				
BASE CASE	85	90				← E_B
A_1	89	30				← E_{A_1}
A_2						← E_{A_2}
A_3						← E_{A_3}

c. Add $MOTE_1$ values. Subsequently add $MOTE_2$ values, etc.

Examples:

$$\begin{array}{r} 85 \\ 89 \\ \hline 174 \end{array} \qquad \begin{array}{r} 90 \\ 30 \\ \hline 120 \end{array}$$

d. Divide each MOTE value by the sum of the MOTE values from previous step shown in the examples. This produces a relative effectiveness score within each MOTE.

$$174\overline{)85.00} = .49 \qquad 120\overline{)90.00} = .75$$

	$MOTE_1$	$MOTE_2$	$MOTE_3$	$MOTE_4$	ΣE	
WEIGHTS* →	90	50				
BASE CASE	.49	.75				← E_B
A_1	.51	.25				← E_{A_1}
A_2						← E_{A_2}
A_3						← E_{A_3}

e. When previous steps have been completed for all training systems and all MOTEs, multiply the decimal value (relative effectiveness score) produced in Step d times the weight assigned to the particular MOTE and insert the product (weighted relative effectiveness score) into the appropriate spaces on the matrix.

	$MOTE_1$	$MOTE_2$	$MOTE_3$	$MOTE_4$	ΣE	
WEIGHTS* →	90	50				
BASE CASE	44.1	37.5				← E_B
A_1	45.9	12.5				← E_{A_1}
A_2						← E_{A_2}
A_3						← E_{A_3}

f. Add the values for the base case and for each training alternative across the horizontal. Insert the sums (total weighted effectiveness score) in the appropriate "E" spaces in the training system matrix.

Examples:

44.1	45.9
37.5	12.5
81.6	58.4

	$MOTE_1$	$MOTE_2$	$MOTE_3$	$MOTE_4$	ΣE	
WEIGHTS*	90	50				
BASE CASE	44.1	37.5			81.6	← E_B
A_1	45.9	12.5			58.4	← E_{A_1}
A_2						← E_{A_2}
A_3						← E_{A_3}

g. List the total life cycle costs for each training program alternative as shown in the example below.

h. Determine the total number of hours (or other appropriate unit of use) of useful life of the systems and list as shown below.

i. Divide results of Step g by the results of step h as shown in the example below. Insert the quotients as shown.

	BASE CASE	A_1	A_2	A_3
TOTAL LIFE CYCLE COSTS	25,175,000	20,000,000		
TOTAL LIFE CYCLE UTILIZATION UNITS	1800	1800		
LIFE CYCLE COST PER UNIT	13,986.11	11,111.11		
	C_B	C_{A_i}	C_{A_2}	C_{A_3}

j. The comparison of training program alternatives is a cost benefit analysis with formulae as shown below. These formulae show the comparison among a base case (BC) and three alternatives (A_1, A_2, A_3). The left column shows the combinations of comparisons of two alternatives at a time. With fewer alternatives there will be fewer combinations of two. Each pair comparison has a corresponding formula in the right column. These equations establish efficiency ratios (e.g., $\frac{E_B}{E_{A1}}$) which when multiplied by the "cost per unit" (step i above) give a product to be compared with the "cost per unit of the other alternative of the pair.

$BC \cdot A_1 \quad C_B \leq C_{A_1} \frac{E_B}{E_{A_1}}$

$BC \cdot A_2 \quad C_B \leq C_{A_2} \frac{E_B}{E_{A_2}}$

$BC \cdot A_3 \quad C_B \leq C_{A_3} \frac{E_B}{E_{A_3}}$

$A_1 \cdot A_2 \quad C_{A_1} \leq C_{A_2} \frac{E_{A_1}}{E_{A_2}}$

$A_1 \cdot A_3 \quad C_{A_1} \leq C_{A_3} \frac{E_{A_1}}{E_{A_3}}$

$A_2 \cdot A_3 \quad C_{A_2} \leq C_{A_3} \frac{E_{A_2}}{E_{A_3}}$

k. Start by selecting two alternatives for comparison. For the following example, the base case is compared with alternative one.

BC A_1

l. Find the appropriate formula from paragraph j above, right column.

Example: $C_B \leq C_{A1} \frac{E_B}{E_{A1}}$

m. Divide the measure of efficiency for the base case (E_B) by the measure of efficiency (E_{A_1}) of the alternative.

$$E_B = 81.6 = 1.4$$

$$E_{A_1} \quad 58.4$$

n. Multiply the value obtained in Step m by the cost per unit use for the first alternative training system (C_{A_1}) (from Step 9).

11,111.11) x (1.4) = 15,555.55

o. Compare the value obtained from Step n with the "cost per hour use" for the base case (C_B). The mathematical symbol "≤" means "equal to or less than". If C_B is "equal to" the value obtained in Step n, the two systems are equal on a cost benefit comparison. If C_B is "less than" the value obtained in Step n, the base case is better than the first alternative. If C_B is "greater than" the value obtained in Step n, the alternative is better than the base case.

p. Make cost benefit comparisons between each of the remaining systems (if any).

q. Select the optimal system.

4. DIVAD Gun

Given alternatives rank-ordered on the basis of estimated effectiveness and cost estimates for the alternatives, establish a cost effectiveness matrix similar to the following.

Alternatives	Effectiveness	Cost	Overall Ranking
1	3	3	3
2	2	2	2
3	1	1	1

In the DIVAD Gun CTEA, for example, the estimated cost of Alternative 1 was roughly three times the cost of Alternative 3 (which was estimated to be the most effective alternative). Alternative 3 was easily identified as the best choice.

Your situation may not fall into place as nicely as this DIVAD Gun case, but again your expertise and judgment will have to suffice if you have no other data.

5. DRIMS CTEA (USAIS, Diagnostic Rifle Marksmanship Simulators, Cost and Training Effectiveness Analysis, August 1978)*

This method has been used by the Infantry School and is particularly appropriate in comparing alternative simulators of an operational weapon system (base case) as a result of testing.

a. List the critical skills that must be taught by the alternative systems you are comparing. Provide columns for each alternative.

*Adapted from the cited study.

b. For each alternative check the cell for each critical skill the alternative can teach, as in the example below. Obviously, the operational system will meet all the critical skill requirements.

Teach Critical Skill	Alt 1	Alt 2	Alt 3
Skill 1		X	X
2	X	X	X
3	X		X
4		X	X
5	X		X
	X		
n			

c. For each alternative compute the percentage of the total number of critical skills that the alternative has the capability of teaching.

d. Rank order the alternatives for the factor, Relative Capability of Teaching the Critical Skills from highest to lowest (1 to n).

e. Determine from your test data what you will use as your measure of training effectiveness. In the DRIMS CTEA, for example, the relative training effectiveness (RTE) factor was based on overall probability of hit (P_H), since it provided the most stable index of rifle firing proficiency. RTE in this case is defined as:

$$RTE = \frac{\text{Overall } P_H \text{ of the alternative training device}}{\text{Overall } P_H \text{ of the baseline M16/M193}}$$

RTE is an index of the relative effectiveness of each alternative training device with respect to the baseline weapon or system. If RTE is 1.0, an alternative is equal to the baseline in terms of training effectiveness. If it is less than 1.0, it is less effective than the baseline. Rank order the alternatives based on the RTE from highest to lowest (1 to n).

f. Determine the cost of each alternative relative to the base case.

$$RC = \frac{\text{Cost of alternative}}{\text{Cost of base case}}$$

Rank order the alternatives based on the RC of each from lowest to highest (1 to n).

g. Determine relative user acceptance (RUA). "User acceptance is an important factor in any decision to choose a training device. Far too often

devices remain in the training room and are never utilized due to lack of user acceptance and perceived value. These attitudes often cannot be finitely evaluated but they must be appraised."* From test or survey data:

$$RUA_1 = \frac{\text{number of trainers preferring Alternative 1}}{\text{number of trainers preferring base case}}$$

Rank order the alternatives based on the RUA of each from highest to lowest (1 to n).

h. Add the rankings for the four factors of each alternative. Determine the overall rank order of the alternatives with the most preferable alternative having the lowest sum.

i. Figure III-30 is an example of the ranking factors and ranking of training alternatives from the cited study.

6. Analogous Task Method

Having determined the effectiveness of two or more analogous tasks (see paragraph C3 above), compare the training programs of each on the basis of the proven effectiveness of each and the cost of each.

7. TECEP

Having developed alternative training programs by the procedures in Section IIIB2 above, compare the programs on the basis of relative cost and your judgment of their merits as you work them through the practicality test in that section.

*DRIMS CTEA, p. 46.

RANKING FACTORS	BASELINE ALTERNATIVES			
	M16	WPNEER	LTRN	RFA
RELATIVE TRAINING EFFECTIVENESS (RTE)				
Record Fire P_H	1.0	1.01	0.99	1.00
Relative Training Effectiveness Rank	(1)	(1)	(1)	(1)
RELATIVE COST (RC)				
a. Table 4, Section V	1.0	0.08	0.05	0.10
b. Relative Cost Rank	(4)	(2)	(1)	(3)
RELATIVE CAPABILITY (RCP)				
a. Table IV-I	1.0	0.86	0.50	0.64
b. Relative Capability Rank	(1)	(2)	(4)	(3)
RELATIVE USER ACCEPTANCE (RUA)				
a. CET of Weaponeer & Lasertrain dated Oct 77	1.0	4.33	1.0	0.33
b. Relative User Acceptance Rank	(2)	(1)	(2)	(3)
TOTAL OF RANKINGS (LOWEST SCORE MOST COST AND TRAINING EFFECTIVE)	(8)	(6)	(8)	(10)
FINAL ALTERNATIVE RANKINGS	(2)	(1)	(2)	(3)

Figure III-30. Ranking Factors and Ranking of Training Alternatives

F. Resolution of Issues

1. ITV CTEA (TRADOC, Cost and Operational Effectiveness Analysis for the Improved TOW Vehicle (ITV), Part IV, Cost and Training Effectiveness Analysis, June 1978).

All the issues you will have to resolve in your CTEA cannot be predicted. For example, one of the objectives of the above cited CTEA was to determine if it were more cost effective to train the system at Fort Benning or at Fort Knox. The alternatives considered were:

- Alternative #1 - Train TOWCAP at Fort Knox and Fort Benning.
- Alternative #2 - Train ITV and ground mount at Fort Benning.
- Alternative #3 - Train ITV and ground mount at Fort Knox.
- Alternative #4 - Train ITV at Fort Benning and TOW ground mount at Fort Knox.
- Alternative #5 - Train TOW ground mount at Fort Benning and ITV at Fort Knox.

For the effectiveness portion it was assumed that training at Fort Benning and training at Fort Knox were equally effective. (You must be very careful in making such assumptions and in all your assumptions.) The cost analysis showed that Alternative #3 was the most cost effective (i.e., Fort Knox was determined to be the least cost training location for the ITV and ground mount).

Normally, the system for which your school is the proponent will be trained at your school but some, of course, will involve two or more schools as with the TOW. This process method merely illustrates one way of resolving the training location issue as a guide and reference.

2. DRIMS CTEA (USAIS, Diagnostic Rifle Marksmanship Simulators Cost and Training Effectiveness Analysis, August 1978).

Given issues to resolve such as user acceptance and capability of alternatives to teach required skills, you may be able to resolve them as in the cited method.

Use the procedure outlined in paragraph E5 above under "Comparison of Training Alternatives" to determine the relative ranking of alternatives with respect to the issues.

3. Trainability Analysis

This method is a way to resolve the issue of trainability of tasks. First, compare task descriptions and training programs with available data on personnel characteristics. On the basis of this informal (subjective) comparison, rate the risk that a task cannot be adequately trained as (1) High, (2) Moderate, or (3) Low.

Compare the tasks with mission analyses or operational concepts and rate the criticality of each task to the mission as (1) High, (2) Moderate, or (3) Low.

Construct a matrix such as in Figure III-31 showing risk versus criticality. Where high risk-high criticality tasks coincide, great concern for trainability is indicated, where moderate risk-moderate criticality tasks coincide, moderate concern is indicated; and where low risk-low criticality, high risk-low criticality, or low risk-high criticality tasks coincide little or no concern is indicated.

CRITICALITY	RISK		
	(1) HIGH	(2) MODERATE	(3) LOW
(1) HIGH	H	M	L
(2) MODERATE	M	M	L
(3) LOW	L	L	L

H = HIGH CONCERN

M = MODERATE CONCERN

L = LOW CONCERN

Figure III-31. Trainability Concern Matrix

G. Sample Procedure

In order to help you tie the processes together into a CTEA, the following hypothetical example exercises the general CTEA model that has been discussed.

Situation

You have been required to perform a CTEA on a new air defense system (System X) that is in its early stages of development to counter a short range air defense (SHORAD) threat. Concurrently, procurement of a simulator for training is being considered. The purpose of your CTEA is to allow decision makers to assess the training impacts of the system, both as to the estimated cost and the estimated effectiveness of training on the system.

Procedures

1. Assessment of Data and Choice of Strategy

Using the guidelines of Figure II-1, General CTEA Model (p. II-2), assess the available data. You find you have no training program and no task list for the developing system. This requires Strategy 1 (p. II-7), and you find you will need to do all the processes:

a. Generate a task list,

b. Predict training programs,

c. Estimate effectiveness,

d. Cost the training programs,

e. Compare the training program alternatives,

f. Resolve issues.

2. Generate a Task List

Table II-1 (p. II-7) lists three methods for generating a task list. After reading Section IIIA (starting on p. II-1), you decide the DIVAD Gun approach most nearly matches your situation. As an air defense subject matter expert (SME), you have some familiarity with System X and considerable knowledge concerning air defense. You know, for example, that the system is a missile system that will employ new scanning, acquisition, and tracking subsystems that are not radar. There will be an optical sighting subsystem as backup. The missile will have an improved infrared (IR) lock-on capability. You also know that although there will be an identification of friend or foe (IFF) subsystem, visual identification will be needed as backup. You start to build your task list:

- Perform preventive maintenance checks and services (PMCS) on the system.

- Perform troubleshooting procedures on the system.

- o Acquire targets
- o Track targets
- o Engage targets
- o Visually identify aircraft

3. Prediction of Alternative Training Programs

The next step is the development of alternative programs to train the tasks on the list you have drawn up.* Consulting Table II-1, Column B, you find four suggested methods for predicting training programs: TEEM, TECEP, DIVAD Gun, and ATM. Since you have generated a task list and you are familiar with earlier systems that train similar tasks, you decide to use ATM to predict alternative training programs.

Three tasks -- acquire, track and engage targets -- group themselves into a set that will be trained together. The action verbs are on the ATM task verb list. You have found two similar weapon systems that require that operators be trained to track a target in a continuous, regulatory movement and have found close comparability among all three systems on the initiating cues, cue characteristics, responses to cues, response characteristics, and feedback categories and characteristics (see ATM example, III.B.4, p. III-21).

The next step is to look at the training programs of these two predecessor systems -- System A and System B. You find the following:

System A teaches target-related tasks in the institution. Crewmen at Level 1 are instructed in a school-taught, 529-hour course without self-pacing. One instructor is assigned 10 students. The System A POI schedules twenty-five hours of instruction in these skills. Ammunition is allotted at the rate of .1 System A guided missile per student to be used during the five hours of instruction that takes place in the field. The student is expected to be 90% accurate to pass this part of his course.

System B trains target acquisition, tracking, and engagement in a moving target simulator in a controlled environment. Twenty training hours (two in conference and 18 in practical experience) are allotted. The trainee is expected to engage successfully 80% of the targets presented. This training is followed by five hours of examination tracking live targets. Ammunition requirements for this task are .2 System B guided missile per student.

You know that the new system will be taught in the same type school environment and be subject to approximately the same course length and facilities. You know that a simulator is being considered. Using the training for Systems A and B as models, you can now predict alternative programs for this set of tasks for System X. You might present them as follows:

---

*From this point on we will use one set of related tasks to illustrate the CTEA model. In an actual CTEA you would, of course, use the entire task list.

Alternative 1

20 hours of classroom instruction
5 hours of instruction in the field
1 instructor
10 students
1 System X guided missile per class
A set of visual aids for identifying targets

Alternative 2

2 hours of classroom instruction
18 hours of practical experience in a moving target simulator
5 hours of examination tracking live targets in the field
1 instructor
10 students
2 System X guided missiles per class

4. Estimate Effectiveness

You must now estimate how successful each of these programs will be in training soldiers to be System X missile crewmen. Unless the CTEA you are conducting takes place after some field testing and/or production of a prototype simulator, you will not be able to field test the alternative training programs and determine their relative effectiveness. Therefore, you can choose one of the methods recommended for Process C, Estimation of Effectiveness (TEEM, DIVAD Gun, ATM, TRAINVICE, or TCA, see p. III-35 to III-77). Since you were successful in finding the target-related tasks taught in analogous systems, you will probably continue to use ATM.

In the process of predicting the training programs you find 90% accuracy was required for System A trainees and 80% for System B. You study the historical data at the school and find that 70% of the System A students and 85% of the System B students pass their examination of this set of tasks at the end of training. You now have estimates of effectiveness based on the effectiveness of the analogous programs you used to develop your proposed alternative.

5. Cost the Training Program

This analysis is taking place early in the life cycle of System X and you do not find firm cost data available. You consider several approaches. You decide that the reliability of the data indicate that the per student costs of training for Analogous Systems A and B will be most suitable. You note that the cost of development of the proposed training device will be so large as to outweigh any differences in the operating costs of the two programs so you omit this from your calculations leaving its assessments for the required separate device COEA. You foresee no unusual training [illegible] connected with System X. School historical data show that it costs $80[illegible] to train each student when trained on System A and $1200, on System B. You will use these as estimated costs for the proposed Alternatives 1 and 2.

6. Compare the Training Program Alternatives

You now have estimates of the effectiveness of two programs designed to train the selected task and of the institutional cost to train a student to perform the task. The costs of the two programs and are on the same basis since you are excluding the necessarily high cost of developing and purchasing a new training simulator. You have chosen normal annual operating costs. Since you have used the ATM for both estimates, this low level of precision indicates that you continue to use ATM to compare the training programs. You found in your earlier assessment (Par. 4 and 5) that:

A	B	C	D	E	F
Training Program Alternative	Program Effectiveness	Crewmen Performance Effectiveness	Overall Effectiveness (BXC)	Cost (Class of 10)	Cost/Effectiveness Ratio (Col. E ÷ Col. D)
1	.70	.90	.63	$ 8,000	12,698
2	.85	.80	.68	$12,000	17,647

The first program produces fewer but more accurate crewmen at the lower cost per class. The second produces trained students more effectively but they are less proficient and more expensive. On calculating the C/E you find a lower value for Alternative 1 and therefore can report that it is the more cost effective. Be aware, however, that if a criterion level of effectiveness has been established, you may be spending money needlessly on effectiveness that exceeds that criterion.

7. Resolve Issues

Some issues may have been posed as questions in your authorizing letter of instruction. For example, you are asked to assess two installations, X and Y, as to suitability for live fire target practice. You find that only X has in existence a usable range. Energy costs are lower at Y, construction costs lower at Y, but environmental impact is not favorable.

Another issue you address is trainability. (You assess this factor using method in III.F.3, p. III-137.) The tasks of target acqusition, tracking, and engaging are among the most critical. On examination of the personnel capabilities and the two analogous training programs, you find that the majority of trainees are trained to criterion. Since System X has features such as the new scanning, acquisition, and tracking subsystems and improved IR lock-on capability, you have good reason to believe that it will be easier to operate and be more effective. Therefore, although task criticality is high, training risk is judged low and you report that on the issue of task trainability, there is little concern.

8. Prepare Report

The last step in the CTEA process is the preparation of a clear, comprehensive, well-documented report on the findings with recommendations as warranted.

Formats will vary but such recent CTEA reports as the DIVAD Gun (1979) and the U. S. ROLAND Missile System (1978) can serve as models. You will want to refer to the TRADOC Training Effectiveness Analysis Handbook as well.

Once completed, your report will serve both as an aid to decision makers and also as a basis or starting point for all other requirements for CTEA input during the life of System X.

ANNEX A

TEEM

Appendix 1

MEDIA RELATED VARIABLES

STIMULI CHARACTERISTICS

Medium of Stimuli Presentation

1. Visual Cues - Signals received through the sense of sight.

2. Audio Cues - Signals received through the sense of hearing.

3. Tactile Cues - Signals received through the sense of touch, including sensations related to texture, size, shape, or vibration of the skin.

4. External Stimulus Motion Cues - The sensations felt by a person when he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.

5. Internal Stimulus Motion Cues - The sensations felt by a person when he moves his arm, leg, fingers, etc.

6. Olfactile Cues - Signals received through the sense of smell.

7. Gustatile Cues - Signals received through the sense of taste.

Visual Form

8. Visual Alphanumeric - Words and/or numbers presented visually.

9. Visual Symbolic - Symbols presented graphically.

10. Visual Graphic - Two-dimensional figures, such as maps, graphs, mathematical curves, etc., presented visually.

11. Visual Pictorial - Two-dimensional images, such as photographs, drawings, etc., presented visually.

12. Visual Solid Object - A three-dimensional image or reality that is viewed from exterior perspectives.

13. Visual Environment - A three-dimensional image or reality that is viewed from inside.

Visual Movement

14. Visual Still - A static visual field, as with a still photograph, drawing or printed page.

15. Visual Limited Movement - A basically static visual field with elements that can be made to move, as with an animated transparency or simple panel with switches that move.

16. Visual Full Movement - A visual field in which all elements can move, as with a motion picture, flight simulator, or operational aircraft.

17. Visual Cyclic Movement - A visual field which moves through a fixed sequence and then repeats the sequence in a repetitive manner, as with a film loop.

Visual Spectrum

18. Black and White - A visual field composed of either black or white elements, as with the printed page or line drawings.

19. Gray Scale - A visual field composed of black, white and continuous gradations of gray, as with a black and white photograph or television picture.

20. Color - A visual vield composed of various segments of the visual spectrum, as with color television or motion pictures.

Visual Scale

21. Exact Scale - Actual visual field or a one-to-one replication of that field as with a full-sized mock-up, simulator, or operational system.

22. Proportional Scale - A representation of reality in other than full scale, such as a scaled model map or photograph.

Visual Contrast

23. Dim - A visual object which blends in with its background, i.e., there is a small or no luminance difference between an object and its background.

24. Bright - A visual object which is brighter than its background, i.e., there is a large luminance difference between an object and its background.

Audio Sources

25. Tonal Sound - A very limited source of sound or noise which is used, rather than speech, for signaling or warning, e.g., horns, whistles, sirens, bells, buzzers, etc.

26. Voice Sound - A limited source of sound which enables spoken words to be used as the medium of communications, but not suited to more demanding tasks, such as music or sound recognition exercises.

27. Full Sound - A source of sound that contains all the significant elements of the sound and is suited to the demanding task of sound recognition exercises.

28. Ambient Sound - A complex sound environment with sounds emanating from various sources and from various directions, including background noise and task significant sounds.

Audio Stimuli Intensity

29. Weak - Audio stimuli presented to the trainee which have weak intensity.

30. Strong - Audio stimuli presented to the trainee which have strong intensity.

Stimuli Presentation

31. Static - A unitary stimuli situation, i.e., stimuli are presented to the trainee "all at once", e.g., batch presentations.

32. Dynamic-Ordered - A sequential stimuli situation, i.e., stimuli are presented to the trainee sequentially or in an ordered manner over time.

33. Dynamic-Random - A non-sequential stimuli situation, i.e., stimuli are presented to the trainee randomly over time.

Stimuli Presentation Rate

34. Slow Rate - A slow rate or speed of presentation of stimuli to the trainee, allowing the trainee a long or maximum stimulus analysis time.

35. Fast Rate - A fast rate or speed of presentation of stimuli to the trainee, allowing the trainee a short or minimum stimulus analysis time.

Number of Channels or Sources

36. Limited - A small number of sources, channels, or instruments through which stimuli are presented to the trainee.

37. Unlimited - A multiple number of sources, channels, or instruments through which stimuli are presented to the trainee.

Stimuli Distribution

38. Individual - All information is presented directly to one individual trainee.

39. Group - Information is presented to a group of trainees, allowing only indirect access to the information for an individual.

Appendix 2

MEDIA RELATED VARIABLES

RESPONSE CHARACTERISTICS

Response Mode of Implementation

1. Overt Response - Verbal - A response which the trainee expresses in an audible (verbal) manner, such as a verbal short answer response to a question having a limited set of correct answers, a conversational response, or a verbal decision response.

2. Overt Response - Written - A response which the trainee expresses in an observable (written) manner, such as a free style written response, a written multiple choice response, or a written fill-in-the blank response.

3. Overt Response - Manipulative Acts - A response which the trainee expresses in an observable (manipulative) manner, such as the small movements of dials, switches, keys, or small adjustments to instruments or the large movements of levers, wheels or use of hand held tools.

4. Overt Response - Tracking - A response which the trainee expresses in an observable (tracking) manner, such as continuously controlling a constantly changing system, e.g., steering an automobile.

5. Overt Response - Procedural Performance - A response which the trainee expresses in an observable (procedural performance) manner, such as performing a sequence of steps in a procedure, e.g., carrying out the items on the checklist for preflighting an aircraft or turning on a radar system.

Intensity of Response

6. Weak - Responses made by the trainee with weak intensity.

7. Strong - Responses made by the trainee with strong intensity.

Response Implementation

8. Static - A unitary response situation, i.e., responses are made by the trainee "all at once".

9. Dynamic-Ordered - A sequential response situation, i.e., responses are made by the trainee sequentially or in an ordered manner over time.

10. Dynamic-Random - A non-sequential response situation, i.e., responses are made by the trainee randomly over time.

Required Response Rate

11. Slow Rate - A slow rate or speed of trainee response, i.e., a rate which allows the trainee a long or maximum response time.

12. Fast Rate - A fast rate or speed of trainee response, i.e., a rate which allows the trainee a short or minimum response time.

Number of Response Channels

13. Limited - A limited number of sources, channels, or instruments through which required responses are made by the trainee.

14. Unlimited - An unlimited number of sources, channels, or instruments through which responses are made by the trainee.

Response Distribution

15. Individual - One individual trainee makes the required response.

16. Group - A group of trainees make the required response.

Appendix 3

MEDIA RELATED VARIABLES

INFORMATION FEEDBACK LOGIC

Medium of Feedback Presentation

1. Visual - Feedback presented visually by means of a display, it may be coded and transmitted visually to the trainee.

2. Aural - Feedback presented aurally by means of a display to the trainee.

3. Written Form - Feedback presented to the trainee in written form.

4. Face-to-Face Communication - Feedback presented by direct verbal means to the trainee.

5. Indirect Communication - Feedback presented by indirect verbal means, such as by intercom, telephone, or radio link.

6. Tactile - Feedback presented to the trainee through the sense of touch, including sensations related to texture, shape, size, or vibration of the skin.

7. Kinesthetic - Feedback presented to the trainee by either internal or external bodily movement, such as reaching, grasping, tilting, etc.

8. Olfactile - Feedback presented to the trainee through the sense of smell.

9. Gustatile - Feedback presented to the trainee through the sense of taste.

Source of Feedback

10. Intrinsic F - Information or cues built into the system from which the trainee interprets feedback information.

11. Extrinsic F - Information or cues not inherent in the trainee action or system operations but is supplied by an external source.

Type of Feedback

12. Research Correctness (Rcr) - Information about the correctness or incorrectness of trainee's response, when several response alternatives are possible and the correct choice is not known to the trainee in advance. (Also known as augmented feedback.)

13. Response Correctness (Rcf) - Information provided to the trainee (or others who need to know about his performance) that he has in fact performed the operation, but does not say anything about the longer range consequences of the action taken.

14. Response Consequences (Rcn) - Information about the consequences of the action taken. It confirms the response made by the trainee, and the correctness of a response can be inferred only from its consequences. May also serve to cue the trainee to perform the next response in sequence.

15. System Status (Rss) - Information about the condition of one's own or another system or the external environment, on the basis of which a trainee or team must act. Information is not necessarily (or even frequently) the immediate consequence of or follow-on to a specific trainee/team action; it may reflect system events that have been put in motion by much earlier trainee actions. Provides information that regulates trainee and system actions in the sense that when a particular status condition occurs, the trainee must often take action to maintain the integrity of his system.

Feedback Distribution

16. Individual - Feedback is presented to one individual trainee.

17. Group - Feedback is presented to a group of trainees, allowing only indirect access for an individual.

FUNCTIONAL CONTEXT VARIABLES

ROLE OF ELEMENT - The social function performed by the trainee within the system's operational context.

1. Supervisory - The trainee's function is unequal to functions being performed by other individuals; the role is basically one of overseeing or directing.

2. Team Performance - The trainee's function is equal to functions being performed by other individuals; the function is basically one of teamwork and cooperation.

3. Individual Performance - The trainee's function is one of performing alone, usually without supervision or team assistance.

FUNCTION PERFORMED IN ROLE - The primary actions performed within each role.

4. Mental - An action occurring or experienced in the trainee's mind, as contrasted with overt physical activity.

5. Physical - An overt bodily action performed by the trainee.

6. Perceptual - An action by the trainee involving perception or observation.

7. Communicative - An action by the trainee in which he transmits either a written or verbal message.

STABILITY OF FUNCTION - The function's state, quality, or degree of being constant overtime.

8. Unstable - The trainee's function is not constant or regular, it is characterized by continual change and fluctuation.

9. Stable - The trainee's function has little change or fluctuation over time.

PHYSICAL CONTEXT - The significance of the physical environment upon performance of the task.

10. Low Impact - The physical environment has little or no significant impact on performance of the task.

11. High Impact - The physical environment has a large or significant impact on performance of the task.

PSYCHOLOGICAL IMPACT - The significance of the psychological environment upon performance of the task.

12. Low Impact - The psychological environment has little or no significant impact on performance of the task.

13. High Impact - The psychological environment has a large or significant impact on performance of the task.

Appendix 5

TRAINING EQUIPMENT & MATERIALS

Visual Only Systems

1. Case Study Folders - Folders with illustrative studies showing cause and effect information, may include pictures, graphs, maps, charts, etc.

2. Flash Cards - A set or deck of cards designed to present information to a group or individual student.

3. Printed Materials - Handouts - Handouts are a class of printed materials issued to a student for his use and retention to augment regular instructional materials. They are usually instructor prepared, machine copied materials of one or two pages highlighting specific topics or updating existing materials.

4. Printed Materials - Performance Aids - Performance aids are a class of printed materials that display data to aid in job performance or to identify facts or background information. They include conversion tables, data charts, schematic diagrams, equipment test tolerance matrices, checklist routines, maps, and the like.

5. Printed Materials - Reference Books - Reference books are a class of printed materials used to identify certain facts or for background information such as dictionaries, encyclopedias, technical publications, guides or manuals.

6. Printed Materials - Workbooks and Exercises - A class of printed materials used to augment or replace instructional texts by providing a mix of text information and/or practice exercises and quizzes.

7. Printed Materials - Textbooks - Textbooks are a class of printed material dealing with a subject of study and used as a principal source of organized information.

8. Programmed Text - A printed text containing frames of information, either in the form of questions requiring the trainee to construct simple written responses, multiple choice questions, etc. The material is carefully sequenced, tested, and revised to ensure that a specific student population will achieve stated behavioral objectives with a predetermined level of success.

9. Filmstrip Projection System - A single frame projector or attachment thereto that will accept a filmstrip format and project the film images upon a viewing screen.

10. Microform - Microimagery, such as microfilm, used as a medium of instruction.

11. Overhead Projection System - A system consisting of a horizontal stage projector designed to use a vertical throw for focusing an enlarged transparency image upon a projection screen.

12. Slide Projector System - 2" x 2" - A class of single frame picture projectors that will accept a standard 2" x 2" slide and project the contained image upon a viewing screen.

Audio Only Systems

13. Audio Disc System - An audio system that uses a record player and sound recorded on a disc (record).

14. Audio Tape System - An audio system that uses a tape recorder/reproducer to record sound on magnetic tape.

15. Language Laboratory - Audio - An audio presentational device that distributes audio information via a control console to student stations equipped with headsets, and may have a microphone for console/instructor-student intercommunication and a tape recorder. Student may interact with taped instructional material, rewind and play back or store responses. Student responses may be monitored or recorded at console.

16. Radio System - AM/FM - A passive audio system consisting of a broadcast studio, transmitting station, and student radio receivers. The system uses designated AM/FM frequency bands for information transmission.

17. Radio System with Responders - A multi-channel two-way radio communication system that operates within UHF or VHF-FM frequency bands limiting broadcast ranges. Network may be open or use encoding/decoding techniques or responders for individual channel privacy.

18. Telephone System - A telephone system with switching matrix capability that allows multiple station two-way audio communication at two or more remote locations.

Audio-Visual Systems

19. Carrel - A small enclosure or alcove incorporating a desk, can be used by one or two trainees and can be equipped with AV equipment or tools or print materials or a combination of these.

20. Dial Access Information Retrieval System - Audio/Video - Dial access information retrieval is an electronic system for distributing audio and/or visual materials and programs which are stored in a location remote from where they are dialed and received.

21. Filmstrip Projection System with Audio - A sound filmstrip projector represents a family of audio-visual devices using single frame visual filmstrips with sound on magnetic tape or records. Visuals and sound may be manually or automatically synchronized. Commercial equipment options include front or rear screen projection, remote and stop action capability, and cartridge loading models.

22. Microform with Audio - Microimagery, such as microfilm, used as a medium of instruction with audio tape or disc, etc.

23. Motion Picture Projection System - 16MM and Super 8MM Films - A motion picture projection system using professionally or locally prepared 16mm or S-8mm sound motion picture films for training. Appropriate 16mm or S-8mm projector and projection screen are included.

24. Sound Slide Projection System - A system for presenting information by means of an audio tape and a series of synchronized projected visual slides.

25. Teaching Machine - Still Visual/Audio - An individualized instruction system composed of programmed instruction still frames, such as large step multiple choice or fixed linear sequence, and/or synchronized sound, and a manually controlled device to display the audio and/or visual information.

26. Teaching Machine - Motion Visual/Audio - An individualized instruction system composed of programmed instruction motion frames, such as large step multiple choice or fixed linear sequence, and/or synchronized sound, and a manually controlled device to display the audio and/or visual information.

27. Televideo System - A telecommunication system that allows audio and visual two-way communication between two or more remote locations.

28. Television - Cable (CATV) - A hybrid CCTV system offering selective, multiple channel, encoded programming to cable network patrons. A typical system consists of a signal receiving antenna system for the master station and relay of amplified signal channels via area substations to system subscribers. Programming may also be generated and transmitted between substations offering multiple options for conference or training. Programs are encoded for privacy and control of viewing audience.

29. Television - Cartridge (CTV) - A cartridge television system (CTV) consists of packaged video tape programs, video recorder, playback and display units, and control equipment offering high selectivity and availability for individualized programming. Program cartridges may be prerecorded, locally produced, or recorded off-the-air.

30. Television - Closed Circuit (CCTV) - CCTV is an electronic transmission system for images and sound using a coaxial cable distribution system. System design includes one or more studios or control rooms, a signal distribution center, and signal distribution cables terminating in reception areas equipped with receiver/monitors. Off air, live or video taped programs may be used.

31. Television - Non-Magnetic Video Disc System - An experimental form of television, similar in function to cartridge television, in which the program is encoded on a thin plastic disc, distributed to users where it is rotated at high revolutions per minute on a player which reads the data and sends program signals into the antenna terminals of a standard color television receiver. Random access capability.

32. Computer - A programmable electronic device that can store, retrieve, and process data. It may manage and display information to a student, accept student responses, provide feedback, perform calculations, etc.

33. Demonstrator - A low fidelity simulator that demonstrates manipulative principles, movement in time or space, steps of a procedure, etc.

34. Mock-up and Panel - A training aid used to demonstrate relative shape, size, composition or function of an object or system display. It may have moving parts, such as dials, switches, levers, etc., or have non-moving parts, such as cutaway or layout models, etc.

35. Operational Equipment - A unit of or the entire equipment used on the job for training purposes where extreme fidelity is required.

36. Physiological Trainers (Hostile Environment) Auditory - training devices designed to place controlled stress on the human hearing system through use of a physiologically and/or psychologically adverse sound environment, to enable a trainee to learn to function in this adverse environment.

37. Physiological Trainers (Hostile Environment) Visual - A training device designed to place controlled stress on the human visual system, through the use of physiologically and/or psychologically adverse or low threshold visual signals, to enable a trainee to learn to function in this adverse environment.

38. Physiological Trainers (Hostile Environment) Surface and Internal Senses - A broad category of training devices designed to provide the cutaneous, kinesthetic and olfactory sensors with physiologically and/or psychologically adverse signals, to enable a trainee to function in adverse pressure, temperature, pain or disorientating motion environments.

Appendix 6

Training Methods

1. Lecture-Standard: A semiformal discourse in which the instructor presents a series of events, facts, concepts, or principles; explores a problem; or explains relationships. Trainees participate in a lecture mainly as listeners. A lecture is basically a means of "telling" trainees information they need to know. Not all talking done by an instructor during a class period can be termed a lecture, the term describes a more formal presentation used to achieve an instructional objective.

2. Lecture-Team Teach: A semiformal discourse in which two (or more) instructors present a series of events, facts, concepts, or principles; explore a problem; or explain relationships. Trainees participate in a lecture mainly as listeners. A lecture is basically a means of "telling" trainees information they need to know. Not all the talking done by the instructors during a class period can be termed a lecture, the team describes a more formal presentation used to achieve an instructional objective.

3. Conference-Directed Discussion: Group discussion techniques are used to reach instructional objectives. These techniques include questions, answers, and comments from the instructor in combination with answers, comments, and questions from the trainees, and are directed toward attainment of learning goals. The objective in directed discussion is to help trainees acquire better understanding and the ability to apply known facts, principles, concepts, policies, or procedures, or to provide trainees with an opportunity to apply their knowledge. The function of the instructor is to guide the discussion in such a way that the facts principles, concepts, or procedures are clearly articulated and applied.

4. Conference-Seminar: Group discussion techniques are used to reach instructional objectives. These techniques include questions, answers, and comments from the instructor in combination with answers, comments, and questions from the trainees, and are directed toward attainment of learning goals. The purpose of the seminar is to find an answer to a question or a solution to a problem. The instructor does not have an answer or solution; in fact there is no known best or correct solution. Rather, he is seeking an answer, and he uses the group to develop one. The primary functions of the instructor are to describe the problem as he understands it and to encourage free and full participation in a discussion aimed at (1) identifying the real problem, (2) gathering and analyzing data, (3) formulating and testing hypotheses, (4) determining and evaluating alternative courses of action, (5) arriving at conclusions, and (6) making recommendations to support or arrive at a solution or a decision.

5. Demonstration: The instructor actually performs an operation or does a job, thereby showing the trainee what to do and how to do it; he then uses explanations to point out why, where, and when it is done. Usually, the trainee is expected to be able to repeat the job or operation after the demonstration.

6. Performance-Manual-Independent Practice: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In independent practice, trainees work individually and at their own rate.

7. Performance-Manual-Student Tutor: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In the student tutor method, trainees are paired and members of each pair perform alternately as instructor and trainee.

8. Performance-Manual-Group Practice: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In group performance, a group of trainees perform an operation or function involving teamwork.

9. Performance-Manual-Group Controlled Practice: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In group controlled practice, trainees work together at the rate set by the instructor, step by step and "by the numbers".

10. Programmed Instruction: A method of self-instruction in which the trainee works through a carefully sequenced and pretested series of steps leading to the acquisition of knowledge or skills representing the instructional objectives. The trainee proceeds through the program at his own rate, responds actively (or covertly) to each step in the sequence, and receives immediate feedback on the correctness of his response before proceeding to the next step. Programs are usually designed to permit the trainee to master the desired knowledge or skills.

11. Study Assignment-Individual Study: In the study assignment method, the instructor assigns readings in books, periodicals, manuals, or handouts; requires the completion of a project or research paper; or prescribes problems and exercises for the practice of a skill. In independent study, the trainee carries out the assignment without instructor assistance or direct guidance.

12. Study Assignment-Supervised Study: In the study assignment method, the instructor assigns readings in books, periodicals, manuals, or handouts; requires the completion of a project or research paper; or prescribes problems and exercises for the practice of a skill. In supervised study, the trainee carries out the assignment with an instructor available for guidance and assistance.

13. Tutoring: An instructor works directly with an individual trainee. The method may involve exposition, demonstration, questioning, coaching, or guided practice.

14. Case Study: Involves in-depth group discussion of real-life situations. It requires reading, study, analysis, discussion, and free exchange of ideas as well as decision making and the selling of decisions to others. A case report is distributed to trainees. The report contains a factual and accurate picture, based on firsthand observation, of a situation that portrays people acting, interacting, and reacting. Trainees study the case report and discuss it in depth.

15. Incident Method: A variation of the case method in which only a brief sketch of the climax of a case is presented. Trainees are given a few minutes to study the incident and attempt to determine the information they need to find out what is going on. Trainees then get these facts by asking questions of the leader. Time is usually limited, and questions must be of the type that can be answered "yes" or "no", or by a simple factual statement. The group then determines the nature of the problem and the decisions needed to solve it. Each member writes an individual decision with supporting reasons. Group discussion of the case in general and the decisions reached follows.

16. Role Playing: A laboratory method of instruction that involves the sponaneous dramatization or acting out of a situation by two or more persons under the direction of a trainer. The dialog grows out of the situation developed by the trainees assigned to the parts. Each person acts his role as he feels it should be played. Other trainees serve as observers and critics. Following the enactment, the group engages in discussion.

17. Sensitivity (Laboratory or T-Group) Training: A deliberate effort to apply behavioral science to problems of motivation, communication, problem solving, and teamwork. Basically, sensitivity training is small-group interaction under stress in an unstructured group composed of learners and a trainer. The objective is behavioral change. To attain the objective, a permissive or supportive environment is established by the trainer. Participants are encouraged to act their own roles, receive feedback, examine their concepts of self, experiment with and practice new patterns of behavior, and learn how to maintain changed behavior back on the job.

18. Games: Games include a set of structured decision-making tasks typical of a real-life situation and provide a systematic means of observing and evaluating trainees' decisions. These, then, are fed back to the trainees so that they can judge their appropriateness. Most games are played by one or more teams, each composed of from one to twenty participants. There may or may not be interaction between teams. Games are usually played in periods -- an interval of time which may represent a month, a quarter, or a year. Trainees are given information in the form of reports or a scenario and allowed time to study the situation and make decisions. These decisions are processed either by a control group of judges or by a computer. The resulting data or scenario projections are returned to the team for analysis, and another decision.

19. In-Basket Exercises: The in-basket situation is composed of a representative sample of a full year's performance in all aspects of a job. Trainees are given background materials, organization charts, policy manuals, financial statements, reports, and position papers to study before the exercise begins. Each trainee is then exposed to a structured array of memos, reports, letters, telephone calls, visits, and meetings. In his role as a manager, the trainee makes decisions on the incoming "mail." In each instance he commits himself in writing to specific courses of action. Time limits are established to introduce realism and cause stress. The decision-making phase is followed by discussion and critique of the actions taken and decisions reached. All actions are analyzed, evaluated, and fed back to participants.

20. Brainstorming: A small, carefully selected group is given a "how to" question or problem and is asked to produce as many ideas or solutions as they can generate. Usually a time limit is set. The technique of free association is encouraged. Quantity of ideas or solutions takes precedence over quality. Judgments about the worth of ideas or solutions are deliberately postponed until a later time. Ideas are written on a chalkboard or flip chart as fast as they are called out.

21. Committees: A group of trainees, ranging in size from three to seven, is given a special assignment in the form of a problem. The group is asked to investigate the problem, reach conclusions, and recommend a solution or a course of action. The committee may produce a report which is often presented orally to the larger group.

22. Field Trips: A carefully planned visit or tour to a place away from the training activity. The purpose of the trip is to provide firsthand observation of objects, processes, operations, and situations not transportable to, or reproducible in, the training facility. The field trip may take less than an hour when it involves a visit to an adjoining plant, office, or shop; or it may consume several days or weeks as would be the case with a visit to a distant plant or an overseas installation.

23. Panels: Three to ten people, under the direction of moderator, present their views on a particular subject or problem, or present assigned phases of a broad topic. Usually, panelists represent different kinds of expertise, experience, or perspectives. Often they are drawn from operating and staff elements. At times experts from outside the enterprise are invited to participate. Sometimes trainees themselves serve as members of panels. Following the presentations by the panelists, trainees are encouraged to participate through questions directed to individual panelists.

ANNEX B

TECEP
(TAEG REPORT NO. 16)

AD-A102 274 LITTON MELLONICS SYSTEMS DEVELOPMENT DIV ARLINGTON VA F/6 5/1
COST AND TRAINING EFFECTIVENESS ANALYSIS (CTEA) PERFORMANCE GUI--ETC(U)
SEP 80 R K MATLICK, D C BERGER, M H ROSEN MDA903-79-C-0326

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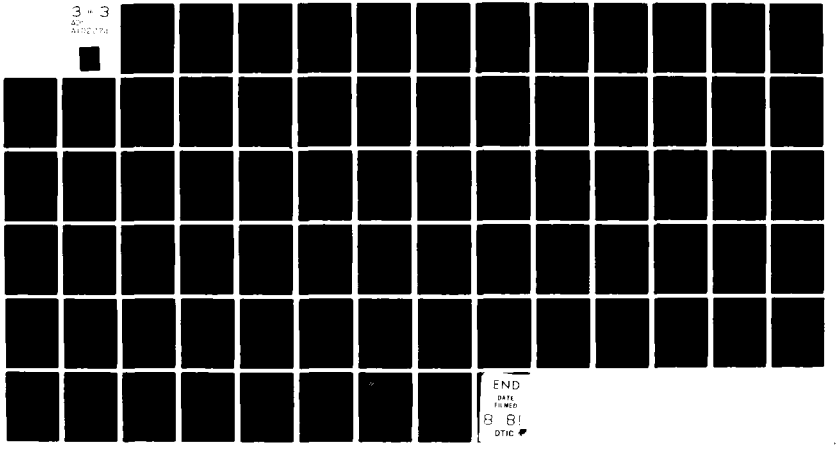

ANNEX B
Appendix 1

TAEG Report No. 16

Table B-1-1

TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
1. RECALLING BODIES OF KNOWLEDGE	Answer Define Express Inform Select	1. Concerns verbal or symbolic learning. 2. Concerns acquisition and long-term maintenance of knowledge so that it can be recalled.	1. Recalling equipment nomenclature or functions. 2. Recalling system functions, such as the complex relations between system input and output. 3. Recalling physical laws, such as Ohm's law. 4. Recalling specific radio frequencies and other discrete facts.
2. USING VERBAL INFORMATION	Apply Arrange Choose Compare Determine	1. Concerns the practical application of information. 2. Generally follows the initial learning of information through the use of the guidelines for Recalling Bodies of Knowledge. 3. Limited uncertainty of outcome. 4. Usually little thought of other alternatives.	1. Based on academic knowledge, determine which equipment to use for a specific real world task. 2. Based on an academic knowledge of the system, compare alternative modes of operation of a piece of equipment and determine the appropriate mode for a specific real world situation. 3. Based on memorized knowledge of radio frequencies, choose the correct frequency in a specific real world situation.
3. RULE LEARNING AND USING	Choose Conclude Deduce Predict Propose Select Specify	1. Choosing a course of action based on applying known rules. 2. Frequently involves "If...Then" situations. 3. The rules are not questioned, the decision focuses on whether the correct rule is being applied.	1. Apply the "rules of the road." 2. Solve mathematical equations (both choosing correct equation and the mechanics of solving the equation). 3. Carrying out military protocol. 4. Selection of proper fire extinguisher for different type fires. 5. Using correct grammar in novel situations, covered by rules.
4. MAKING DECISIONS	Choose Design Diagnose Develop Evaluate Forecast Formulate Organize Select	1. Choosing a course of action when alternatives are unspecified or unknown. 2. A successful course of action is not readily apparent. 3. The penalties for unsuccessful courses of action are not readily apparent. 4. The relative value of possible decisions must be considered - including possible trade-offs. 5. Frequently involves forced decisions made in a short period of time with soft information.	1. Choosing frequencies to search in an ECM search plan. 2. Choosing torpedo settings during a torpedo attack. 3. Threat evaluation and weapon assignment. 4. Choice of tactics in combat - wide range of options. 5. Choosing a diagnostic strategy in dealing with a malfunction in a complex piece of equipment. 6. Choosing to abort or commit oneself to land upon reaching the critical point in the glidepath.

Table B-1-1

TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT (continued)
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
5. DETECTING	Detect Distinguish Monitor	1. Vigilance - detect a few cues embedded in a large block of time. 2. Low threshold cues; signal to noise ratio may be very low; early awareness of small cues 3. Scan for a wide range of cues for a given "target" and for different types of "targets."	1. Early sonar detection of a submarine target. 2. Visually detecting the periscope of a snorkeling submarine during daytime operations in a sea state of three. 3. Detect, through a slight change in sound, a bearing starting to burn out in a power generator.
6. CLASSIFYING	Identify Recognize Differentiate Classify	1. Pattern recognition approach of identification - not problem solving. 2. Classification by non-verbal characteristics. 3. Status determination - ready to start. 4. Object to be classified can be viewed from many perspectives or in many forms.	1. Classify a sonar target as "sub" or "non-sub." 2. Visual classification of flying aircraft as "friend" or "enemy" or as an "F-4." 3. Determining that an identified noise is a wheel bearing failure, not a water pump failure by rating the quality of the noise - not by the problem solving approach.
7. IDENTIFYING SYMBOLS	Identify Read Transcribe	1. Involves the recognition of symbols. 2. Symbols to be identified typically are of low meaningfulness to untrained persons. 3. Identification, not interpretation, is emphasized. 4. Involves storing queues of symbolic information and related meanings.	1. Reading electronic symbols on a schematic drawing. 2. Identifying map symbols. 3. Reading and transcribing symbols on a tactical status board. 4. Identifying symbols on a weather map.
8. VOICE COMMUNICATING	Advise Answer Communicate Converse Direct Express Instruct Interview Listed Order Report Speak	1. Speaking and listening in specialized languages. 2. Often involves the use of a specific message model. Standard vocabulary and format. 3. Also concerns clarity of voice, enunciation, speed. 4. Timing of verbalization is usually critical - when to pass information. 5. Typically characterized by redundancy in terms of information content. 6. Involves extensive use of previously overlearned verbal skills, or overcoming overlearned interfering patterns. 7. Task may be difficult due to presence of background noise.	1. Officer giving oral orders and receiving reports. 2. Sonar operator passing oral information over communication net. 3. Instructions by GCA operator to pilot in landing aircraft.

Table B-1-1

TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT (continued)
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
9. RECALLING PROCEDURES, POSITIONING MOVEMENT	Activate Adjust Align Assemble Calibrate Disassemble Inspect Operate Service	1. Concerns the chaining or sequencing of events. 2. Includes both the cognitive and motor aspects of equipment set-up and operating procedures. 3. Procedural check lists are frequently used as job aids.	1. Recalling equipment assembly and disassembly procedures. 2. Recalling the operation and check out procedures for a piece of equipment (cockpit check lists). 3. Following equipment turn-on procedures - emphasis on motor behavior.
10. STEERING AND GUIDING - CONTINUOUS MOVEMENT	Control Guide Maneuver Regulate Steer Track	1. Tracking, dynamic control: a perceptual-motor skill involving continuous pursuit of a target or keeping dials at a certain reading such as maintaining constant turn rates, etc. 2. Compensatory movements based on feedback from displays. 3. Skill in tracking requires smooth muscle coordination patterns - lack of overcontrol. 4. Involves estimating changes in positions, velocities, accelerations, etc. 5. Involves knowledge of display-control relationships.	1. Submarine bow and stern plane operators maintaining a constant course, or making changes in course or depth. 2. Tank driver following a road. 3. Sonar operator keeping the cursor on a sonar target. 4. Air-to-air gunnery - target tracking. 5. Aircraft piloting such as: visually following a ground path. 6. Helmsman holding a course with gyro or magnetic compass.
11. PERFORMING GROSS MOTOR SKILLS	Cut Draft Draw March Mix Run Sew Sharpen Splice Swim Weld Write	1. Perceptual-motor behavior-emphasis on motor. Premium on manual dexterity, occasionally strength and endurance. 2. Repetitive mechanical skill. 3. Standardized behavior, little room for variation or innovation. 4. Automatic behavior - low level of attention is required in skilled operator. Kinesthetic cues dominate control of behavior. 5. Fatigue or boredom may become a factor when skill is performed over an extended period of time or at a rapid rate. 6. Fine tolerances. 7. Often a component of a larger task.	1. Use of hand tools such as hammer, saw, wrench, or power tools such as lathes or grinders. 2. Running a drill press in an assembly line. 3. Loading ammunition into artillery pieces or 5" guns. 4. Drafting - use of drafting instruments. 5. Painting - house painting or preserving ship hull, etc. 6. Marching - close order drill.

Table B-1-1

TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT (continued)
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
12. ATTITUDE LEARNING	Abide Accept Approve Comply Testify	1. Concerns exhibiting a pattern of behavior consistent with an attitude or value. 2. Concerns willingness to perform according to a standard as opposed to skill to perform according to that standard. (Note: A person can have a high level of skill but choose not to perform in a skillful manner.) 3. Concerns integrating or organizing a value or attitude into a pattern of behavior.	1. Complying with known safety standards while performing a maintenance procedure on a high voltage supply in a radar set. 2. Conforming to the standard of keeping one's bunk area neat and clean when the opportunity exists to do otherwise. 3. Abiding by security regulations when handling classified information. 4. Accepting the need to take risks when necessary to protect the lives of teammates. 5. Complying with a request to repair a malfunctioning radio circuit with greater than normal speed when a quick response is required.

ANNEX B
Appendix 2

TAEG Report No. 16

Table B-2-1

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

RECALLING BODIES OF KNOWLEDGE

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems	Alternative Instructional Delivery Systems								
	Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm			
	CAI	Teaching Machine - Branching	Microfiche with Self-Scoring Tests	Programmed Text - Branching with Self-Scoring Tests	Audio Visual Carrel with Program Texts, AV Modules and Self-Scoring Tests	Traditional Classroom with Instructor, Overhead Projector, Texts, and Paper and Pencil Tests	Independent Study Using Textbooks, Handbooks, Tests and Workbooks	Instructional Television Broadcast or CCTV Without Feedback, Tests	Programmed Text - Linear with Instructor Scored Criterion Test
Stimulus Criteria									
● Visual Movement									
Limited	X	X			X			X	
Full	X				X			X	
● Visual Spectrum									
Full Color	X	X	X		X	X	X	X	
● Audio									
Voice Sound Range	X	X			X	X		X	
Full Sound Range					X				
Training Setting Criteria									
● Individual Trainees at Fixed Location	X	X	X	X	X	X		X	X
● Individual Trainees with Simultaneous Instruction at Many Locations								X	
● Individual Trainees with Independent Instruction at Any Location			X	X			X		X
● Small Group						X		X	
● Large Group at a Single Location						X		X	
● Team Setting									
Administrative Criteria									
● Site of Courseware and Special Hardware Development									
Local			X	X	X	X	X		X
Central	X	X	X	X	X		X	X	X
● Magnitude of Acquisition Cost									
Low			X	X		X	X		X
High	X	X			X			X	

Table B-2-2

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

USING VERBAL INFORMATION

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems

	Alternative Instructional Delivery Systems								
	Delivery Approaches Permitting the Application of ALL Learning Guidelines and Algorithm						Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm		
	Computer Assisted Instruction with Adjunct Equipment and Materials	Programmed Text - Branching	Programmed Text - Branching with Paper Simulation	Teaching Machine - Branching Still Visual	Microfiche with Self-Scoring Tests	Tutor with Diagnostic Tests and Instructor's Guide with Student Exercises	Traditional Classroom	On-the-Job Training	
Stimulus Criteria									
● Visual Movement									
Limited	X			X			X	X	
Full	X						X	X	
● Visual Spectrum									
Full Color	X		X	X	X		X	X	
● Audio									
Voice Sound Range	X			X		X	X	X	
Full Sound Range								X	
Training Setting Criteria									
● Individual Trainees at Fixed Location	X	X	X	X	X	X		X	
● Individual Trainees with Independent Instruction at Any Location		X	X		X				
● Small Group							X		
● Large group at a single location							X		
● Team Setting								X	
Administrative Criteria									
● Site of Courseware and Special Hardware Development									
Local		X	X		X	X	X	X	
Central	X	X	X	X	X	X			
● Magnitude of Acquisition Cost									
Low		X	X		X	X	X	X	
High	X			X					

Table B-2-3

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

RULE LEARNING AND USING

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems	Alternative Instructional Delivery Systems: Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm								Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm		
	Operational Equipment with Instructor and Instructor Handbook	Simulator with Instructor and Instructor Handbook	Procedure Trainer with Instructor and Instructor Handbook	Computer Assisted Instruction	Teaching Machine, Branching	Programmed Text, Branching	Microfiche with Self-Scoring Tests	Traditional Classroom	Programmed Instruction - Linear	
Stimulus Criteria										
● Visual Form				X	X	X	X	X	X	
Pictorial, Plane				X	X	X	X	X	X	
Line Construction, Plane	X	X	X					X		
Object, Solid	X	X	X							
Environment										
● Visual Movement		X	X	X	X			X		
Limited	X	X	X	X						
Full										
● Visual Spectrum				X	X	X	X	X	X	
Gray Scale	X	X	X	X	X		X	X		
Color										
● Audio	X	X	X	X	X			X		
Voice Sound Range	X	X	X							
Full Sound Range	X	X								
Ambient Sounds										
● Other	X	X	X							
Tactile Cues	X	X	X							
Internal Stimulus Motion Cues	X	X								
External Stimulus Motion Cues										
Instructional Setting Criteria	X	X	X	X	X	X	X	X	X	X
● Individual Trainee at Fixed Location							X	X		X
● Individual Trainee with Independent Instruction at Any Location									X	
● Small Group									X	
● Large Group at a Single Location										
Administrative Criteria										
● Site of Courseware and Special Hardware Development							X	X	X	X
Local	X	X	X	X	X	X	X	X		X
Central										
● Magnitude of Acquisition Cost				X		X	X	X	X	X
Low	X	X	X	X	X					
High										

Table B-2-4

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

MAKING DECISIONS

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems	Alternative Instructional Delivery Systems: Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm						Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm			
	Simulator Diagnostic Tests with Instructor	Manual Simulation Game with Diagnostic Tests and Instructor	CAI with Adjunct Equipment and Materials	*Teaching machine* - Branching	Microfiche with Self-Scoring Tests	Programmed Text - Branching with Self-Scoring Tests	Operational System with Tutor	Case Study Materials w/wo Instructor	Role Playing Materials with Instructor	
Stimulus Criteria										
● Visual Form										
Alphanumerics		X	X	X	X	X		X	X	
Pictorial, Plain		X	X	X	X	X		X	X	
Object, Solid	X						X		X	
● Visual Movement										
Still		X	X	X	X	X		X		
Full Movement	X		X				X			
● Audio										
Voice Sound Range	X	X	X	X			X		X	
Full Sound Range	X						X			
● Other										
Tactile Cues	X						X			
External Stimuli: Motion Cues	X						X			
Training Setting Criteria										
● Individual Trainee at Fixed Location	X	X	X	X	X	X	X	X		
● Independent Trainee with Independent Instruction at Any Location					X	X				
● Small Group							X	X	X	
● Team Setting	X	X					X		X	
Administrative Criteria										
● Site of Courseware and Special Hardware Development										
Local		X			X	X		X	X	
Central	X	X	X	X	X	X	X	X	X	
● Magnitude of Acquisition Cost										
Low		X			X	X		X	X	
High	X		X	X			X			

Table B-2-5

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

DETECTING

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery syetems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems							
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm		
		Operational System with Stimulated Signals, and an Instructor with Instructor Handbook	Simulator with Instructor and Instructor Handbook	Simulator with Adjunct Displays and Logic	Procedure Trainer, with Instructor and Instructor Handbook	Procedure Trainer with Adjunct Displays and Logic	Operational System with Instructor	Informal On-the-Job Training on Operational System	
Stimulus Criteria									
● Full Visual Environment		X					X	X	
● Full Ambient Sounds		X	X	X			X	X	
● External Stimulus Motion Cues		X	X	X			X	X	
Training Setting Criteria									
● Individual Trainee at Fixed Location (Schoo.)		X	X	X	X	X	X		
● Individual Trainee On-the-Job		X					X	X	
Administrative Criteria									
● Site of Courseware and Special Hardware Development									
Local							X	X	
Central		X	X	X	X	X			
● Magnitude of Acquisition Cost									
Low								X	
High		X	X	X	X	X	X		

Table B-2-6

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

CLASSIFYING

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems	Alternative Instructional Delivery Systems										
	Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm					
	CAI w/Adjunct Equipment and Materials	Study Card Sets	Microfiche	Teaching Machine - Branching	Simulator with Adjunct Displays or Instructor	Slide Sets with Instructor	Traditional Classroom with AV Materials	Audio Recorders - Disc or Tape	Specimen Set	Sound Slide/Film Strip Program	
Stimulus Criteria											
● Visual Form											
Alphanumeric	X	X	X	X	X	X	X			X	
Pictorial, Plane	X	X	X	X		X	X			X	
Line Construction, Plane	X	X	X	X		X	X			X	
Object, Solid					X				X		
Environment					X						
● Visual Movement											
Still	X	X	X	X		X	X		X	X	
Limited	X			X			X			X	
Full					X		X				
● Scale											
Exact Scale					X				X		
● Audio											
Voice Sound Range	X			X	X	X	X	X		X	
Full Sound Range					X			X			
Ambient Sounds					X						
Other Tactile Cues					X				X		
Internal Stimulus Motion Cues					X						
External Stimulus Motion Cues					X						
Training Setting Criteria											
● Individual Trainee at a Fixed Location	X	X	X	X	X	X		X	X	X	
● Individual Trainee with Independent Instruction at Any Location		X	X					X		X	
● Small Group						X	X	X		X	
● Large Group at Single Location						X	X	X		X	
Administrative Criteria											
● Site of Courseware and Special Hardware Development											
Local		X	X	X		X	X	X	X	X	
Central	X	X	X	X	X	X	X	X	X	X	
● Magnitude of Acquisition Cost											
Low		X	X			X	X	X	X	X	
High	X			X	X						

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Table B-2-7

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

IDENTIFYING GRAPHIC SYMBOLS

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems									
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm				
		CAI (with visual display)	Teaching Machine - Branching	Programmed Text - Branching	Microfiche with Self-Scoring Tests	Study-Card Sets with Self-Scoring Tests	Traditional Classroom	Textbook	Chart	Automatic Rater	
Training Setting Criteria											
● Individual Trainee at a Fixed Location		X	X	X	X	X		X	X	X	
● Individual Trainee with Independent Instruction at Any Location				X	X	X		X	X		
Administrative Criteria											
● Site of Courseware and Special Hardware Development											
Local				X	X	X	X	X	X	X	
Central		X	X	X	X	X		X	X	X	
● Magnitude of Acquisition Cost											
Low				X	X	X	X	X	X	X	
High		X	X								

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Table B-2-8

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

VOICE COMMUNICATING

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in bokes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems							
		Delivery Approaches *Permitting the Application* of All Learning Guidelines and Algorithm			Delivery Approaches NOT *Permitting Complete* Application of Learning Guidelines and Algorithm				
		Simulator with Instructor, Instructor Handbook, and Diagnostic Tests	*Procedure Trainer with* Instructor, Instructor Handbook and Diagnostic Tests	Language Laboratory, Audio, Active-Compare Mode, with Manual Simulation Game and Instructor	Language Laboratory, Audio, Active-Compare Mode, with Printed Materials	Performance Aid	Traditional Classroom	Operational Equipment in *Real Environment with Instructor*	
Stimulus Criteria									
● Visual Form									
Pictorial, Plane				X	X	X	X		
Solid Object		X	X					X	
● Visual Movement									
Still				X	X	X	X		
Full Movement		X	X					X	
● Audio									
Voice Sound Range		X	X	X	X		X	X	
Ambient Sounds		X	X	X	X			X	
Training Setting Criteria									
● Individual Trainee at a Fixed Location		X	X	X	X		X	X	
● Individual Trainee with Independent *Instruction at Any Location*						X			
● Team Setting		X	X	X		X		X	
Administrative Criteria									
● Site of Courseware and Special Hardware Development									
Local						X	X	X	
Central		X	X	X	X	X			
● Magnitude of Acquisition Cost									
Low				X	X	X	X		
High		X	X					X	

Table B-2-9

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

RECALLING PROCEDURES AND POSITIONING MOVEMENT

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems

	Alternative Instructional Delivery Systems											
	Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithms								Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithms			
	Operational System in Laboratory with Tutor	Simulator with Tutor and Tests	Procedures Trainer with Tutor and Tests	Logic Trainer with Tutor	CAI with Photo or Operable Mockup	Teaching Machine with Photo or Operable Mockup	Microfiche w/wo Photo or Operable Mockup	Programmed Text - Branching	Laboratory Panel with Equipment and Linear Instructional Materials	Operational System in Real Environment with Tutor	Tests, Lectures and Demonstrations	
Complexity Criteria												
● Difficult Motor Acts	X	X	X	X					X	X		
● Smooth Motor Performance at End of Training	X	X	X						X	X		
Stimulus Criteria												
● Visual Form												
Alpha-Numeric	X	X	X	X	X	X	X	X	X		X	
Pictorial, Plane				X	X	X	X	X	X		X	
Object, Solid	X	X	X	X					X	X	X	
● Visual Movement												
Still				X	X	X	X	X	X		X	
Full Movement	X	X	X	X	X				X	X		
● Audio												
Voice Sound Range	X	X	X		X				X	X	X	
Full Sound Range	X	X	X						X	X		
Ambient Sounds	X	X	X							X		
● Other												
Tactile Cues	X	X	X						X	X		
Internal Stimulus Motion Cues	X	X	X						X	X		
Training Setting Criteria												
● Individual Trainee at Fixed Location	X	X	X	X	X	X	X	X	X	X	X	
● Individual Trainee with Independent Instruction at Any Location							X	X				
● Small Group				X							X	
● Large Group at Single Location											X	
● Team Setting	X	X	X	X						X		
Administrative Criteria												
● Site of Courseware and Special Hardware Development												
Local							X	X	X	X	X	
Central	X	X	X	X	X	X	X	X	X	X		
● Magnitude of Acquisition Cost												
Low							X	X	X		X	
High	X	X	X	X	X	X			X	X		

Table B-2-10

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

STEERING & GUIDING — CONTINUOUS MOVEMENT

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems					
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm				Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm	
		Operational System, Real Environment with Instructor and Instructor Handbook	Simulator with Motion Platform and Full Visual Field, Instructor and Instructor Handbook	Simulator (Without Motion Platform and Full Visual Field) Instructor and Instructor Handbook	Procedure Trainer, Instructor and Instructor Handbook	Operational System, Real Environment, Without Instructor	
Stimulus Criteria							
Full Visual Environment		X	X			X	
External Stimulus Motion Cues		X	X			X	
Fine Movement Manipulative Acts		X	X	X		X	
Broad Movement Manipulative Acts		X	X	X	X	X	
Training Setting Criteria							
Individual or Team Training at a Fixed Location		X	X	X	X	X	
Individual or Team Training with Independent Instruction at Many Locations		X				X	
Administrative Criteria							
Site of Courseware and Special Hardware Development							
Local		X				X	
Central		X	X	X	X	X	

Table B-2-11

INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

PERFORMING GROSS MOTOR SKILLS

Criteria for Selecting Instructional Delivery Systems	Directions: To choose a delivery system: 1. Place a "/" (light pencil) in boxes representing criteria (rows) that must be met. 2. Select the delivery systems (columns) that have an "X" in each row designated by a "/". These are the candidate delivery systems.	Alternative Instructional Delivery Systems				
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm		Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm		
		Tutor in a Job-Like Setting with Equipment, if required, an Instructor Handbook and Student Diagnostic Tests	Tutor in a Job-Like Setting with equipment, if required, an Instructor Handbook, Student Diagnostic Tests, and Portable TV with a Record/Playback Capability and a Series of Taped Demonstrations	Programmed Text - Branching and a Series of Film Loops with Equipment, if required, and a Part-Time Instructor with Criterion Tests	Supervisor Managed Informal On-The-Job Training	
Training Setting Criteria						
● Individual Trainee at a Fixed Location		X	X	X		
● Individual Trainee with Independent Instruction at Many Locations				X	X	
● Small Group					X	
● Team Setting		X	X		X	
Administrative Criteria						
● Site of Courseware Development						
Local		X	X	X	X	
Central		X	X	X		

Table B-2-12

TABLE INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

This chart is useful in selecting an instructional delivery system for the affective and behavioral components of attitude learning. For achieving the cognition component use instructional delivery systems suggested for recalling bodies of knowledge

ATTITUDE LEARNING

Criteria for Selecting Instructional Delivery Systems	Directions: To choose a delivery system: 1. Place a "✓" (right pencil) in boxes representing criteria (rows) that must be met. 2. Select the delivery systems (column) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.	Alternative Instructional Delivery Systems						
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm		Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm				
		Operational Job Setting with Instructor and Instructor Handbook with Diagnostic Attitude Tests	Simulated Job Setting with Instructor and Instructor Handbook with Diagnostic Attitude Tests	Role Playing	Case Studies	On-The-Job Training by Supervisors	Lectures, Seminars, etc.	
Training Setting Criteria								
● Individual Trainee at Fixed Location		X	X		X			
● Individual Trainee with Independent Instruction at Many Locations						X	X	
● Small Group		X	X	X	X	X	X	
● Team Setting		X	X	X	X	X	X	
Administrative Criteria								
● Site of Courseware Development								
Local		X		X	X	X	X	
Central		X	X	X	X			
● Magnitude of Acquisition Cost								
Low				X	X	X	X	
High		X	X					

ANNEX C

ATM

ANNEX C
APPENDIX 1

TASK VERB LIST

Verb	Definition[1]	Category[2]
Accomplish	Complete	General
Accumulate	a - Collect (a) b - Add	15 1
Achieve	Complete	General
Acknowledge	a - Answer (a)[3] b - Answer (b)	7,8,9 4
Acquaint	Inform	7,8
Acquire	a - Detect, identify and locate a target in sufficient detail to permit the effective employment of weapons.# b - Position tracking apparatus of a weapon system so that a designated target is tracked.#	4,12 12
Activate	Give power to equipment so that it may begin to operate§	10
Adapt	Modify to fit a new use	3
Add	Perform the mathematical operation of combining numbers into a sum	1

[1]All definitions have been checked against Webster's New World Dictionary, Second College Edition, Cleveland, Ohio: William Collins + World Publishing Co., Inc., 1976. Those definitions designated by a section mark (§) are not found in this dictionary but, in Litton's opinion, are used with sufficient frequency to warrant inclusion in the list. Definitions designated by # are from AR 310-25, Dictionary of U. S. Army Terms.

[2]The definition of categories 1-15 are given in Appendix C along with the synonym relationships among the words in each category; the synonym relationships among words in the "General" category are given in Appendix A.

[3]Many action verbs indicate the process of information transfer without reference to the means of transfer. These verbs are appropriate both to categories 7 and 8. These verbs may also be appropriate to category 9 although signaling is not usually appropriate to the communication of large quantities of information or fine detail. To classify a particular task when these verbs are used, you must also determine the communication process.

Verb	Definition	Category
Adjust	a - Manipulate controls, levers, linkages and other equipment items to return equipment from an out-of-tolerance condition to an in-tolerance condition	11
	b - Adapt (usually used with to)	3
Advise	Inform	7,8
Alert	Inform designated persons that a certain condition exists in order to bring them up to a watchful state in which a quick reaction is possible	7,8,9
Align	Adjust controls to match visual indicators, such as pointers, lines of sight, wave forms, or aural signals, until coincidence is achieved	11
Alter	Modify the method of operation or some component of a unit of equipment	General
Answer	a - Reply in words to a question	7,8,9
	b - React in response to an anticipated visual, auditory or other non-verbal stimulus	4
Apply	a - Spread a substance on a surface	15
	b - Use	General
Appraise	a - Evaluate (a)	1
	b - Evaluate (b)	1
Apprise	Inform	7,8
Ascertain	Obtain exact, first-hand knowledge of a condition	3
Ask	Seek information from a person verbally	7,8,9
Assemble	Perform the various manual operations necessary to place, align, fit, or secure together two or more components to complete a larger, more complex piece of equipment	11
Assure	Ensure	General
Attach	Connect one object to another; in general, it will be a smaller object onto a larger object	11
Attack	Engage (c)	10

Verb	Definition	Category
Attempt	Make an effort to accomplish a task or goal, but with the realization that failure is a possibility	General
Begin	Set in motion some action or process by taking the first step	General
Brief	Inform	7,8
Calculate	Compute	1
Calibrate	Determine and correct the accuracy of a piece of equipment by special measurement or by comparison with a standard	10
Call	a - Shout or announce	7
	b - Communicate with by electromagnetic means (e.g., telephone, radio)	7
Carry	Move a load while supporting it	15
Cease	Stop (a)	General
Change	a - Alter	General
	b - Remove/Replace	11
Check	a - Hold back or restrain	13
	b - Verify the result of an action, the existence of a condition, or the accuracy of measurements	3
	c - Mark with a check	15
Check out	Inspect for satisfactory condition, accuracy, safety, or performance	3
Choose	Select	2
Cipher	Code	1
Classify[4]	Assign objects, symbols, ideas, etc. to categories based on their characteristics	5,6
Clean	Remove dirt, impurities, or extraneous matters	10
Cleanse	Clean	10

[4]Many action verbs indicating the process of classifying are independent of the object classified. These verbs are appropriate both the categories 5 and 6. To classify a particular task when these verbs are used, you must also determine the nature of the classified object.

Verb	Definition	Category
Close	a - Move something so as to block passage through an opening or to and from an enclosure	11
	b - Complete an electrical circuit§	11
Code	Convert a message, document, etc., from ordinary language to a coded system of letters, words, numbers, or symbols	1
Collate	a - Compare	5,6
	b - Gather in order	6
Collect	a - Gather together (stress on physical act of gathering)	15
	b - Classify (stress on identifying objects to be gathered)	5,6
Command	Specify verbally a course of action to be taken by others	7
Communicate	a - Broadcast messages, signals, signs, writing, images, or sounds by wire, radio, visual, or other electromagnetic means (stress on operating the communications equipment)	10
	b - Transmit information (stress on the message transmitted)	7,8,9
Compare	Examine the characteristics of two or more items to determine their similarities and differences	5,6
Complete	End successfully an entire task, operation, or mission, or part thereof	General
Compute	Determine the value by mathematical means	1
Conduct	Manage (a)	2
Confirm	Verify	3
Conform	Adapt	3
Connect	Couple, fasten, or join pieces of equipment	11
Continue	a - Go on with a course, direction or action already in progress	General
	b - Resume an action after stopping	General
Contrast	Compare to identify differences	5,6

Verb	Definition	Category
Control	a - Manipulate repetitively discrete-action switches, linkages and controls to maintain equipment in an in-tolerance condition	12
	b - Steer	13
Convey	a - Transport	15
	b - Give a message to	7,8
Coordinate	Adjust the actions of various people or pieces of equipment so that their combined action is in harmony	2
Count	Add up, one by one, the total number of units in a collection	1
Deactivate	Remove the power so that equipment ceases operation	10
Decide	a - Choose a course of action	2
	b - Make a judgment	2
Decipher	Decode	1
Decode	Convert a coded message, document, etc. into ordinary language	1
Decrease	Lessen in amount	General
Delay	Stop or hinder for a short time	General
Demand	Require	2
Depress	Push down, especially manually	15
Detain	Delay	General
Detect	Become aware of the existence, presence, or fact of a particular condition	4
Determine	a - Ascertain	3
	b - Decide	2
Direct	a - Steer	13
	b - Command	7
Disable	Remove from a state of readiness so as to prevent action§	10

Verb	Definition	Category
Disassemble	Perform the various manual operations necessary to take apart a piece of equipment to the next lower level of sub-assemblies or to the level of component parts	11
Discard	Throw away or get rid of equipment or components which are no longer functional or useful	2
Discharge	a - Unload or empty	15
	b - Fire	10
	c - Perform an obligation	General
	d - Remove stored energy from a battery or capacitor	10
Disconnect	Separate or undo the connection between pieces of equipment	11
Discontinue	Stop (a)	General
Discover	Ascertain	3
Disengage	a - Disconnect or loosen a fastening so that it no longer restricts movement	11
	b - Disconnect or loosen a power transfer device so that power is no longer transferred	10
Disjoin	Disconnect	11
Divide	a - Separate	11
	b - Classify	5,6
	c - Perform the mathematical operation of finding how many times one number contains another number	1
Draft	Draw the preliminary sketch, version or plan of an object	14
Drag	Pull (a)	15
Employ	Use	General
Empty	Pour out or remove the contents of a container	15
Enable	Bring to a state of readiness§	10
Encode	Code	1

Verb	Definition	Category
Endeavor	Attempt	General
Engage	a - Connect or lock a fastening so that movement is restricted	11
	b - Connect or fasten a power transfer device so that power is transferred	10
	c - Attack designated contact	10
Ensure	Make certain; guarantee the existence of a condition	General
Enter	Input§	8
Enumerate	a - Count	1
	b - List	1
Establish	Set up or institute initially	General
Estimate	Evaluate (a)	1
Evaluate	a - Determine the numerical amount or monetary value of equipment	1
	b - Judge the condition or worth in non-monetary terms of a piece of equipment or procedure	1
Examine	a - Interrogate (a)	7
	b - Inspect	4
Execute	Carry out, especially orders or plans	General
Extend	Reach out or draw out to or from a given point	11
Fasten	a - Attach	11
	b - Lock (a)	10
Fill	Pour or put into a container, especially an amount which occupies the entire volume	15
Finish	a - Complete	General
	b - Give a desired effect to a surface	14
Fire	Cause a weapon to emit a projectile	10
Fly	Operate a manned or unmanned aircraft or spacecraft through the air or space, especially after it has left the ground	13
Follow	Go after, either in order or time	General

Verb	Definition	Category
Furnish	Provide	General
Guide	Steer	13
Halt	Stop (a)	General
Handle	a - Control (a) b - Manage (a) c - Steer	12 2 13
Identify	Recognize or determine the exact nature of something	5,6
Illuminate	Give light to an area or display surface	10
Increase	Add to or augment	General
Inform	Give knowledge of something to one or more persons	7,8
Initiate	Bring into practice or action by first doing or using	General
Input	Insert commands and/or data into a machine by electromechanical means (e.g., keyboard)§	8
Insert	Put or fit something into something else	11
Inspect	Look at carefully, especially in order to detect flaws or errors	4
Install	Attach or mount in position for use	11
Instruct	Communicate knowledge in a learning setting	7
Insure	Ensure	General
Interrogate	a - Ask questions of in a systematic manner b - Signal a device or computer so as to receive information regarding the status or condition of its components§	7 8
Introduce	a - Insert b - Initiate	11 General
Isolate	a - Find or identify, especially the cause of an equipment malfunction§ b - Set apart from other objects or people	3 11
Iterate	Repeat, especially a process	General

Verb	Definition	Category
Judge	a - Evaluate (a)	1
	b - Evaluate (b)	1
	c - Decide	2
Junk	Discard	2
Land	Set a manned or unmanned aircraft down on a surface (e.g., land, water) and bring it to a stop (excludes taxiing)	13
Launch	a - Begin the flight of a missile or rocket	10
	b - Send forth with some added force (e.g., launch an aircraft by catapult)	10
Lay	Adjust a gun to proper direction and elevation	11
Light	Illuminate	10
Line	Align	11
List	Make a list or category of people, objects, ideas, etc.	1
Listen for	Be alert to catch an unexpected sound	4
Load	a - Input§	8
	b - Fill	15
	c - Put ammunition in a weapon	11
	d - Place an electrical load on a battery or generator§	11
Locate	a - Isolate (a)	3
	b - Find a location as on a map	5
Lock	a - Fasten shut by means of a lock	10
	b - Jam or force together so as to be immovable (e.g., lock brakes)	10
	c - Put or fasten in a fixed position	11
Log	Record (a)	8
Loosen	Lessen the force applied by a binding or fastening, especially so as to permit movement	15
Lower	Move an object in a downward direction, attitude, or angle	11
Maintain	a - Keep at the same level or position	13
	b - Keep in operating condition or good repair	General

Verb	Definition	Category
Manage	a - Have control over	2
	b - Control (a)	12
	c - Steer	13
Mate	Connect	11
Mend	Repair	10
Monitor	a - Watch or check on the performance or condition of equipment	4
	b - Watch or listen to the output of detection devices (e.g., radar screen)	4
	c - Watch or listen to the transmission of information	7,8,9
Multiply	Perform the mathematical operation of adding a number to itself a specified number of times	1
Note	a - Record (a)	8
	b - Observe (b)	General
	c - Observe (c)	4
Notify	Inform	7,8
Numerate	Count	1
Observe	a - Adhere to, follow, or abide by a set of rules	1
	b - Pay special attention to	General
	c - Look at	4
Obtain	Get possession of or procure, especially by some effort	General
Open	a - Move something so as to permit passage through an opening or access to an enclosure	11
	b - Break an electrical circuit§	11
Operate	Put or keep a piece of equipment in purposeful action	General
Order	a - Arrange in sequence	6
	b - Command	7
	c - Requisition	8
Overhaul	Check thoroughly for needed repairs and to make those repairs and adjustments so as to restore equipment to good working order	10

Verb	Definition	Category
Package	Wrap or box, as for transporting or carrying	10
Park	Maneuver a vehicle into a space where it can be left temporarily	13
Pass	Cause or allow an object to go through or around another (e.g., pass the rope through the eyelet, pass a vehicle on the road)	13
Perform	Act on or do so as to bring to completion	General
Place	Put an object in a particular place, condition, or relation to other objects	11
Play	Cause a video or audio recording to give out images and/or sounds through the operation of a playback device	10
Plug	a - Stop up or fill a hole or gap by inserting a plug	11
	b - To connect an electrical device with a power source by inserting the power cord in a socket or jack (usually used with <u>in</u>)	11
Position	Place	11
Prepare	Make ready, usually for a specific purpose	General
Present	Exhibit or display an image or message on a screen	10
Press	Depress	15
Probe	a - Interrogate (a)	7
	b - Explore manually with a probe	4
Provide	Make available material or services	General
Pull	a - Exert force on an object so as to cause the object to move toward or in the same direction as the source of the force	15
	b - Extract	15
Push	Exert force against so as to move an object away from the source of the force	15
Query	Ask	7,8,9

Verb	Definition	Category
Question	Interrogate (a)	7
Raise	Move an object in an upward direction, attitude, or angle	11
Reach	a - Extend to or touch by thrusting out	11
	b - Penetrate to	11
Read	a - Get the meaning of something written by using the eyes	6
	b - Observe and record values indicated by visual displays or gauges	6
Receive	Get visual or auditory messages or signals by electromagnetic means (e.g., radio, telephone)	10
Record	a - Put in writing for future use	8
	b - Register sound or visual images in some permanent form, such as phonograph disc, magnetic tape, etc., for reproduction on a playback device	10
Recognize	Perceive to be something previously known	5,6
Regulate	a - Control (a)	12
	b - Steer	13
Reiterate	Repeat, especially a spoken message or order for emphasis	7
Release	a - Let go or let loose from the manual application of pressure	15
	b - Set free from a restrictive force (e.g., release the brake)	10
Remove	a - Lift, push, transfer, or carry something away from its current location to another	11
	b - Take an object off of another	11
Repair	Replace or restore damaged, worn out, or malfunctioning components so that the equipment is serviceable, usable, or in operating condition.	10
Repeat	a - Say again	7
	b - Do or make a task, test, or operation an additional time; do over again	General

Verb	Definition	Category
Replace	a - Put something back in the proper place or position	11
	b - Provide a substitute or equivalent for equipment or components of equipment	11
Reply	Respond	7,8,9
Report	a - Give an account of something seen or done, often at regular intervals	7,8
	b - Make known the presence, approach, or occurrence of something or someone	7,9
Request	Ask for something or some action	7,8,9
Require	Ask or insist upon by right of authority	2
Requisition	Submit a written order or request for something	8
Respond	Say in answer	7
Restore	Repair	10
Resume	Begin again or go on with again after interruption	General
Retract	Draw back or draw in some item of equipment	11
Return	Replace (a)	11
Reveal	Present	10
Review	Examine work performed or documents produced to determine adequacy, correctness, preciseness, etc.	2
Revise	Read over carefully and correct, improve, or update a document, procedure, or regulation	3
Rotate	a - Turn around or cause to turn around a center point or axis in either direction	15
	b - Take or cause to take turns in regular succession (e.g., rotate the tires)	11
Scrap	Discard	2
Scrutinize	Inspect	4

Verb	Definition	Category
Seal	a - Close so as to prevent non-destructive opening of a container or enclosure	10
	b - Close completely so as to make airtight or watertight	10
	c - Apply a non-permeable coating to a porous surface, as before painting	10
Secure	a - Make firm, fast or tight	11
	b - Put under restraint; tie up	11
Seize	Take hold of forcibly with the hand; clutch	15
Select	Pick out from among alternatives	2
Send	Transmit	10
Separate	Place the parts of an object in physically separate locations	11
Service	Make or keep fit for service as by inspecting, adjusting, repairing, refueling, etc.	10
Set	Adjust a measuring device to a desired position or to be in conformity with a standard	11
Set up	Arrange a piece of equipment and necessary servicing tools preparatory to checking out or servicing that piece of equipment$	11
Sew	Unite or fasten by stiches made with flexible thread or filament	14
Sharpen	Make sharp or sharper a cutting edge or piercing point	14
Shove	Push	15
Shut	a - Close (a)	11
	b - Fold up or bring together the parts of a device	11
Signal	Communicate by sight (e.g., flags, flashing lights, hand signs) or sound (e.g., Morse code, tones) other than written or spoken language	9
Splice	Unite by interviewing strands or lapping two ends	14

Verb	Definition	Category
Start	a - Begin	General
	b - Set in motion, action, or operation	10
Stay	a - Delay	General
	b - Stop (a)	General
Steer	Manipulate the continuous-action controls of a vehicle (e.g., steering wheel) so as to determine its course or movement	13
Stop	a - Interrupt or end the motion or operation of equipment or the progress of a process	General
	b - Plug (a)	11
Store	a - Put aside for use when needed	11
	b - Put in a warehouse for safekeeping	11
	c - Placing or keeping information in a computer memory	10
Stretch	Extend	11
Strive	Attempt	General
Succeed	Follow	General
Supply	Provide	General
Survey	View comprehensively	4
Switch	Change (b)	11
Subtract	Perform the mathematical operation of deducting or removing one number from another	1
Take	a - Get possession of by force; grasp	15
	b - Obtain possession of or assume control of equipment, not by force or skill (e.g., take control of an aircraft)	2
Take off	Cause an aircraft to leave the surface (e.g., ground, water) in flight	13
Taxi	Cause an aircraft to move slowly along the surface (e.g., ground, water) under its own power as before taking off or after landing	13
Teach	Instruct	7

Verb	Definition	Category
Test	a - Operate equipment on a temporary basis to determine if it is functioning properly	10
	b - Operate equipment to determine the limits of its performance	10
Throw	a - Cause to fly through the air by releasing from the hand while the arm is in rapid motion; hurl	15
	b - Move a lever, clutch, or switch or connect, disconnect, or engage a power source by such movement	11
Tighten	Increase the force applied by a binding or fastening, especially so as to restrict movement	15
Track	a - Keep a gun properly aimed, or to point continuously a target locating instrument at a moving target.#	13
	b - Lock onto a point of radiation and obtain guidance therefrom.#	13
Transfer	a - Convey, carry, or send an object from one place to another	15
	b - Give to another person, especially authority or control	2
Transmit	Send out a message by means of electromagnetic radiation	10
Transport	Carry from one place to another, especially over long distances	15
Troubleshoot	Locate and eliminate the source of trouble in any flow of work or operating system	3
Try	Attempt	General
Tug	Pull at with great force	15
Tune	Adjust equipment to the proper or desired performance level	10
Turn	Rotate (a)	15
Type	Print or display alphanumeric characters or symbols by pressing keys on a keyboard	8
Update	Make conform to the most recent facts, methods, ideas, etc.	3

Verb	Definition	Category
Use	Put or bring a plan or piece of equipment into action or service so as to accomplish an end	General
Utilize	Use	General
Vary	Change (a)	General
Verify	Substantiate the correctness of something by demonstration, evidence, or testimony	3
Wait	Stay or remain in a state of readiness in anticipation of something; await	General
Watch	Observe (c)	4
Weld	Unite metallic parts by heating and allowing the metals to flow together	14
Wield	Handle (a), especially with skill	12

ANNEX C

APPENDIX 2

CATEGORY/SYNONYM LIST

1. Selecting and applying rules

Tasks in this category have as their central behavior deciding which rule is appropriate to the goal and/or applying the appropriate rule properly. Rules specify how quantities, objects, or situations are transformed into other quantities, objects, or situations. The rule may be general (e.g., rule for multiplying two numbers) or it may be a list of possibilities, that is, a series of "If ... then" statements A rule (as opposed to a procedure) is never limited to a single possibility. The correct choice and application of the rule will always lead to accomplishment of the goal.

Verb	Synonyms
Accumulate (b)	Add
Add	Accumulate (b)
Appraise (a)	Estimate; Evaluate (a); Judge (a)
Appraise (b)	Evaluate (b); Judge (b)
Calculate	Compute
Cipher	Code; Encode
Code	Cipher; Encode
Compute	Calculate
Count	Enumerate (a); Numerate
Decipher	Decode
Decode	Decipher
Divide (c)	
Encode	Cipher; Code
Enumerate (a)	Count; Numerate
Enumerate (b)	List
Estimate	Appraise (a); Evaluate (a); Judge (a)
Evaluate (a)	Appraise (a); Estimate; Judge (a)
Evaluate (b)	Appraise (b); Judge (b)
Judge (a)	Appraise (a); Estimate; Evaluate (a)
Judge (b)	Appraise (b); Evaluate (b)
List	Enumerate (b)
Multiply	
Numerate	Count; Enumerate (a)
Observe (a)	
Subtract	

2. Making decisions

Tasks in this category have as their central behavior choosing a course of action when the best available alternative may not be successful. The relative value of success and cost of failure for each alternative must be considered. Often the range of possible alternatives is wide and unspecified and the choice must be made rapidly, without exhaustive consideration of alternatives.

Verb	Synonyms
Choose	Decide (a); Determine (b); Select
Conduct	Handle (b); Manage (a)
Coordinate	
Decide (a)	Choose; Determine (b); Select
Decide (b)	Judge (c)
Demand	Require
Determine (b)	Choose; Decide (a); Select
Discard	Junk; Scrap
Handle (b)	Conduct; Manage (a)
Judge (c)	Decide (b)
Junk	Discard; Scrap
Manage (a)	Conduct; Handle (b)
Require	Demand
Review	
Scrap	Discard; Junk
Select	Choose; Decide (a); Determine (b)
Take (b)	
Transfer (b)	

3. Solving problems

Tasks in this category have as their central behaviors identifying the source of the problem and choosing the actions necessary to correct it. If the actual correction of the problem is likely to be a major part of the task, then "following procedures" may be a more appropriate category. Identifying the problem source usually involves a systematic, exhaustive consideration of the possibilities with little pressure for quick judgments.

Verb	Synonyms
Adapt	Adjust (b); Conform
Adjust (b)	Adapt; Conform
Ascertain	Determine (a); Discover
Check (b)	Confirm; Verify
Check out	
Confirm	Check (b); Verify
Conform	Adapt; Adjust (b)
Determine (a)	Ascertain, Discover
Discover	Ascertain; Determine (a)
Isolate (a)	Locate (a)
Locate (a)	Isolate (a)
Revise	Update
Update	Revise
Verify	Check (b); Confirm

4. Monitoring

Tasks in this category have as their central behavior careful watching or listening for an important signal against a background of other, irrelevant signals. The task may involve prolonged attending to the likely source of the signal or it may involve short but careful examination. Often the frequency of signal occurrence and/or the signal to noise ratio is very low.

Verb	Synonyms
Acknowledge (b)	Answer (b)
Answer (b)	Acknowledge (b)
Acquire	
Detect	
Examine (b)	Inspect; Scrutinize
Inspect	Examine (b); Scrutinize
Listen for	
Monitor (a)	
Monitor (b)	
Note (c)	Observe (c); Watch
Observe (c)	Note (c); Watch
Probe (b)	
Scrutinize	Examine (b); Inspect
Watch	Note (c); Observe (c)

5. Classifying perceptual, non-graphic signals[1]

Tasks in this category have as their central behavior recognizing perceptual patterns as belonging to a particular class or category. The classes may be general (friend or foe) or specific (F-4). While the signal to noise ratio is usually high, the time available for classifying may be short.

Verb	Synonyms
Classify	Divide
Collate (a)	Compare
Collect (b)	
Compare	Collate (a)
Contrast	
Divide	Classify
Identify	Recognize
Locate (b)	
Recognize	Identify

[1]Many action verbs indicating the process of classifying are independent of the object classified. These verbs are appropriate both for categories 5 and 6. To classify a particular task when these verbs are used, you must also determine the nature of the classified object.

b. Identifying graphic symbols[2]

Tasks in this category have as their central behavior recognizing and identifying previously learned graphic symbols. These symbols usually mean little to untrained people. Examples of such symbols include electronic symbols on a schematic drawing, weather map symbols, and tactical status symbols.

Verb	Synonyms
Classify	Divide
Collate (a)	Compare
Collate (b)	Order (a)
Collect (b)	
Compare	Collate (a)
Contrast	
Divide	Classify
Identify	
Order (a)	Collate (b)
Read (a)	
Read (b)	
Recognize	Identify

[2]See note 1.

7. Communicating by voice[3]

Tasks in this category have as their central behavior the giving and/or receiving of information by means of spoken language. The task may involve the use of a specialized language or vocabulary. Standard patterns for both the message and the response are often specified.

Verb	Synonyms
Acknowledge (a)	Answer (a)
Acquaint	Advise; Apprise; Brief; Inform; Notify
Advise	Acquaint; Apprise; Brief; Inform; Notify
Alert	
Answer (a)	Acknowledge
Apprise	Acquaint; Advise; Brief; Inform; Notify
Ask	Query
Brief	Acquaint; Advise; Apprise; Inform; Notify
Call (a)	
Call (b)	Communicate (b)
Command	Direct (b); Order (b)
Communicate (b)	Call (b)
Convey (b)	
Direct (b)	Command; Order (b)
Examine (a)	Interrogate (a); Probe (a); Question
Inform	Acquaint; Advise; Apprise; Brief; Notify
Instruct	Teach
Interrogate (a)	Examine (a); Probe (a); Question
Monitor (c)	
Notify	Acquaint; Advise; Apprise; Brief; Inform
Order (b)	Command; Direct (b)
Probe (a)	Examine (a); Interrogate (a); Question
Query	Ask
Question	Examine (a); Interrogate (a); Probe (a)
Reiterate	Repeat (a)
Repeat (a)	Reiterate
Reply	Respond
Report (a)	
Report (b)	
Request	
Respond	Reply
Teach	Instruct

[3]Many action verbs indicate the process of information transfer without reference to the means of transfer. These verbs are appropriate both to categories 7 and 8. These verbs may also be appropriate to category 9 although signaling is not usually appropriate to the communication of large quantities of information or fine detail. To classify a particular task when these verbs are used, you must also determine the communication process.

8. Communicating by writing or typing[4]

Tasks in this category have as their central behavior the giving of information by means of written or typed language. The task may involve use of a specialized language or vocabulary in standard formats. Tasks involving the receipt of written information fall in category 6.

Verb	Synonyms
Acknowledge (a)	Answer (a)
Acquaint	Advise; Apprise; Brief; Inform; Notify
Advise	Acquaint; Apprise; Brief; Inform; Notify
Alert	
Answer (a)	Acknowledge
Apprise	Acquaint; Advise; Brief; Inform; Notify
Ask	Query
Brief	Acquaint; Advise; Apprise; Inform; Notify
Communicate (b)	
Convey (b)	
Enter	Input; Load (a)
Inform	Acquaint; Advise; Apprise; Brief; Notify
Input	Enter; Load (a)
Interrogate (b)	
Load (a)	Enter; Input
Log	Note (a); Record (a)
Monitor (c)	
Note (a)	Log; Record (a)
Notify	Acquaint; Advise; Apprise; Brief; Inform
Order (c)	Requisition
Query	Ask
Record (a)	Log; Note (a)
Reply	Respond
Report (a)	
Request	
Requisition	Order
Respond	Reply
Type	

[4]See note 3.

9. Communicating non-verbally (signaling)[5]

Tasks in this category have as their central behavior the giving and receiving of information through means other than language, i.e., signals. The signal vocabulary may be narrow (e.g., go/no go; OK/trouble) or wide (e.g., semaphore signals) or the signals may have a direct correspondence to letters (e.g., Morse code).

Verb	Synonyms
Acknowledge (a)	Answer
Alert	
Answer (a)	Acknowledge
Ask	Query
Communicate (b)	
Monitor (c)	
Query	Ask
Reply	Respond
Report (b)	
Respond	Reply
Signal	

[5]See note 3.

10. Following procedures

Tasks in this category have as their central behavior following the steps of a procedure. A procedure is a specific set of actions designed to produce a specific result. The steps may be cognitive, physical, or both. Procedures may be designed to govern operation or repair of equipment. Procedures involving positioning movements or discrete regulatory movements are more appropriate for tasks in categories 11 and 12, respectively.

Verb	Synonyms
Activate	Start (b)
Attack	Engage (c)
Calibrate	
Clean	Cleanse
Cleanse	Clean
Communicate (a)	Send; Transmit
Deactivate	
Disable	
Discharge (b)	Fire
Discharge (d)	
Disengage (b)	
Enable	
Engage (b)	
Engage (c)	Attack
Fasten (b)	Lock (a)
Fire	Discharge (b)
Illuminate	Light
Launch (a)	
Launch (b)	
Light	Illuminate
Lock (a)	Fasten (b)
Lock (b)	
Mend	Repair; Restore
Overhaul	
Package	
Play	
Present	Reveal
Receive	
Record (b)	
Release (b)	
Repair	Mend; Restore
Restore	Mend; Repair
Reveal	Present
Rotate (b)	
Seal (a)	
Seal (b)	
Seal (c)	
Send	Communicate (a); Transmit
Service	
Start (b)	Activate
Store (c)	
Test (a)	
Test (b)	
Transmit	Communicate (a); Send
Tune	

11. Positioning movements

Tasks in this category have as their central behavior positioning movements, either singular or in sequences. Procedures involving positioning movements are also in this category. Tasks involving cognitive procedures are more appropriate to category 10. Tasks involving repeated positioning movements which serve to regulate some state of the equipment should be classified in category 12.

Verb	Synonyms
Adjust (a)	
Align	Line
Assemble	
Attach	Connect; Fasten (a); Mate
Change (b)	Replace (b); Switch
Close (a)	Shut (a)
Close (b)	
Connect	Attach; Fasten (a); Mate
Disassemble	
Disconnect	Disjoin
Disengage (a)	
Disjoin	Disconnect
Divide	Separate
Engage (a)	
Extend	Reach (a); Stretch
Fasten (a)	Attach; Connect; Mate
Insert	Introduce (a)
Install	
Introduce (a)	Insert
Isolate (b)	
Lay	
Line	Align
Load (c)	
Load (d)	
Lock (c)	
Lower	
Mate	Attach; Connect; Fasten (a)
Open (a)	
Open (b)	
Place	Position
Plug (a)	Stop (b)
Plug (b)	
Position	Place
Raise	
Reach (a)	Extend; Stretch
Reach (b)	
Remove (a)	
Remove (b)	
Replace (a)	Return
Replace (b)	Change (b); Switch
Retract	
Return	Replace (a)
Secure (a)	
Secure (b)	

Verb	Synonyms
Separate	Divide
Set	
Set up	
Shut (a)	Close (a)
Shut (b)	
Stop (b)	Plug (a)
Store (a)	
Store (b)	
Stretch	Extend; Reach (a)
Switch	Change (b); Replace (b)
Throw (b)	

12. Discrete regulatory movements

Tasks in this category have as their central behavior regulatory movements which are discrete in nature. That is, discrete movements rather than continuously variable movements are used to control the position or state of the equipment. While the controls are discrete, the state of the system must be continuously monitored and corrected.

Verb	Synonyms
Acquire	
Control (a)	Handle (a); Manage (b); Regulate (a)
Handle (a)	Control (a); Manage (b); Regulate (a)
Manage (b)	Control (a); Handle (a); Regulate (a)
Regulate (a)	Control (a); Handle (a); Manage (b)
Wield	

13. Continuous regulatory movements

Tasks in this category have as their central behavior dynamic perceptual motor coordination to keep the position or state of the equipment at a desired value. Compensating movements are continuously made in response to feedback from the system.

Verb	Synonyms
Check (a)	
Control (b)	Direct (a); Guide; Handle (c); Manage (c); Regulate (b); Steer; Track
Direct (a)	Control (b); Guide; Handle (c); Manage (c); Regulate (b); Steer
Fly	
Guide	Control (b); Direct (a); Handle (c); Manage (c); Regulate (b); Steer
Handle (c)	Control (b); Direct (a); Guide; Manage (c); Regulate (b); Steer
Land	
Maintain (a)	
Manage (c)	Control (b); Direct (a); Guide; Handle (c); Regulate (b); Steer
Park	
Pass	
Regulate (b)	Control (b); Direct (a); Guide; Handle (c); Manage (c); Steer
Steer	Control (b); Direct (a); Guide; Handle (c); Manage (c); Regulate (b)
Take off	
Taxi	
Track	Guide; Control (b); Steer

14. Performing motor skills

Tasks in this category have as their central behavior applying previously learned motor skills. These skills must have been learned to the point that procedural guidelines are unnecessary.

Verb	Synonyms
Draft	
Finish (b)	
Sew	
Sharpen	
Splice	
Weld	

15. Gross motor movements

Tasks in this category have as their central behavior gross motor movements. The movements often require strength and endurance.

Verb	Synonyms
Accumulate	Collect (a)
Apply (a)	
Carry	Transport
Check (c)	
Collect (a)	Accumulate
Convey	Transfer (a)
Depress	Press
Discharge (a)	Empty
Drag	Pull (a); Tug
Empty	Discharge (a)
Fill	Load (b)
Load (b)	Fill
Loosen	
Press	Depress
Pull (a)	Drag; Tug
Pull (b)	
Push	Shove
Release (a)	
Rotate (a)	Turn
Seize	
Shove	Push
Take (a)	
Throw (a)	
Tighten	
Transfer (a)	Convey
Transport	Carry
Tug	Drag; Pull (a)
Turn	Rotate (a)

ANNEX D

COST

ANNEX D

Appendix 1

Glossary of Cost Variables*

APATRS(i)

Annual pay and allowances of troop support (P8 or P2) [5.16]

ASTUPA (i) [4.18; 5.15]

Average annual pay and allowances of students in year i.

BACIMD(i) [4.1; 4.14; 4.2]

Total cost of institutional instructional material development in year i.

BAIMMC(i) [4.1; 4.15]

Total cost of maintenance of institutional instructional material in year i.

BCIMD(i) [4.14]

Cost per student in year i for instructional material development.

BCINST(i) [4.1; 4.17]

Total cost of pay and allowances of all instructors in institutional base training in year i.

BCOPMT(i) [4.13]

Cost per student of maintenance of variable-cost institutional base training equipment in year i.

BCSQFT(i) [4.11]

Cost per square foot of operation and maintenance of training facilities in year i (includes operation, janitorial service, utilities, etc.).

BCUIMD [4.15]

Average annual cost per student for maintenance of instructional material. (This cost is assumed constant but could be made variable on a yearly basis by inserting the appropriate yearly value where used.)

BDACST(i) [4; 4.1]

Total base non-discounted costs for year i.

BEAQCI(i) [4.1; 4.12; 4.2]

Total cost of institutional base equipment acquisition in year i.

---

*Numbers in brackets indicate equations in which these variables occur.

BEMQCI(i) [4.1; 4.13]

Total cost of institutional base equipment maintenance in year i.

BEQCIS(i) [4.12]

Total cost of fixed-cost institutional base training equipment acquired in year i.

BEQIMP(i) [4.12]

Cost per student of the variable-cost institutional base training equipment that must be acquired in year i.

BEQTRS(i) [4.19]

Cost per student for transportation of equipment used in institutional base training in year i.

BFACOS(i) [4.1; 4.2]

Total cost of institutional base facility acquisition in year i.

BFMCOS(i) [4.1; 4.11]

Total cost of institutional base maintenance of facilities in year i.

BINSTR [4.111; 4.17]

Ratio of instructors to students in institutional base training (assumed constant from year to year).

BOMFEQ(i) [4.13]

Cost of operation and maintenance of fixed-cost institutional base training equipment in year i (i.e., not associated with the number of students).

BOVERH(i) [4.17]

Cost per student of institutional base operations overhead in year i.

BPALIN(i) [4.17]

Average annual pay and allowances of an instructor in institutional base training in year i.

BPALST(i) [4.1; 4.18]

Total cost of pay and allowances of students in institutional base training in year i.

BRORAT(i) [4.17]

Ratio of average number of students in initial training on the particular system to average total number of students in institutional base training in year i.

BRVAST [4; 4.2]

Remaining value of facilities, equipment, and instructional materials at end of planning period (N years).

BSQFST [4.111]

Number of square feet of institutional base training facilities required for each student (assumed constant over entire planning period).

BSQFTA [4.111]

Total square feet of facilities required for administration associated with initial training on the system.

BSUPLY(i) [4.16]

Cost per student of institutional base supplies consumed in year i.

BSUPPY(i) [4.1; 4.16]

Total cost of supplies consumed in year i in institutional base training.

BTIME [4.17; 4.18]

Fraction of year spent by each student in insstitutional base training.

BTRANS(i) [4.1; 4.19]

Total cost of travel (including per diem) and equipment transportation in connection with institutional training in year i.

BTRAVL(i) [4.19]

Cost per student for travel (including per diem) in connection with institutional base training in year i.

BTSQFT(i) [4.11; 4.111]

Total square feet of institutional base training facilities required in year i.

BVALUE [2; 3; 4]

The total training costs associated with institutional base training.

d [4; 5; 6]

Discount rate. DOD Instruction 7041.3 prescribes that the rate should be taken to 10%.

EAD [4.2; 5.2; 6.2]

Annual depreciation rate of equipment(assumes straight-line depreciation).

FAD [4.2; 6.2]

Annual depreciation rate of facilities (assumes straight-line depreciation).

FAMMO(i) [5.13]

Cost per student of ammunition expended in institutional field training in year i.

FCINST(i) [5.1; 5.14]

Total cost of pay and allowances in year i of instructors of institutional field training.

FCONSU(i) [5.13]

Cost per student of miscellaneous consumables consumed in institutional field training in year i.

FCOPMT(i) [5.12]

Cost per student of maintenance of variable-cost institutional field training equipment in year i.

FDACST(i) [5, 5.1]

Total non-discounted cost of institutional field training in year i.

FEAQCI(i) [5.1; 5.11; 5.2]

Total cost of acquisition in year i of equipment required for institutional field training.

FEMQCI(i) [5.1; 5.12]

Total cost in year i of operation and maintenance of equipment required for institutional field training.

FEQIMP(i) [5.11]

Cost per student of variable-cost institutional field training equipment that must be acquired in year i.

FEQCIS(i) [5.11]

Total cost of fixed-cost institutional field training equipment acquired in year i.

FEQTRS(i) [5.1]

Total cost of equipment of troop support units attributable to training the task.

FINSTR [5.14]

Instructor to student ratio (assumed constant).

FOMFEQ(i) [5.12]

Cost of operation and maintenance of fixed-cost institutional field training equipment.

FOMTRS(i) [5.12]

Cost of operation and maintenance of troop support equipment attributable to training the task.

FPALIN(i) [5.14]

Average annual pay and allowances of an instructor in institutional field training in year i.

FPALST(i) [5.1; 5.15]

Total cost of pay and allowances in year i of students in institutional field training.

FPATRS(i) [5.1; 5.16]

Total cost of pay and allowances of troop support (P8 or P2) in year i for institutional field training.

FPETRO(i) [5.13]

Cost per student of petroleum products (POL) consumed in institutional field training in year i.

FRVAST [5, 5.2]

Remaining value of equipment and instructional materials used in institutional field training at end of planning period.

FSUPPY(i) [5.1; 5.13]

Total cost of supplies consumed in year in instructional field training.

FTIME [5.14; 5.15]

Fraction of year spent by each student in institutional field training.

FTRANS(i)

Total cost of transportation in year i of equipment and materiel used institutional field training.

FVALUE [2; 3; 5]

The total training costs associated with institutional field training.

IAD [4.2]

Annual depreciation rate of instructional materials (assumes straight-line depreciation).

IVALUE [1; 2]

The total training costs associated with institutional training.

M

Number of tasks contained in the program. [7]

MESL(i) [4.111; 4.12; 4.14; 4.17]

Maximum expected student load.

METL(i) [6.111]

Maximum expected trainee load.

N [4; 4.2; 5; 5.2; 6; 6.1]

Number of years in planning period.

R [4.14]

Number of repetitions of the course in year i (assumed constant).

SI(i) [4.13; 4.15; 4.16; 4.17; 4.18; 4.19; 5.11; 5.12; 5.13; 5.14; 5.15]

Average number of students in institutional training in year i.

SQFTIN [4.111]

Number of square feet of facilities required per instructor (assumed constant).

TU(i) [6.12; 6.13; 6.14; 6.15; 6.16; 6.17]

Number of trainees in unit training in year i.

TVALUE [1; 3; 7]

Total costs attributable to initial training on the task or system being studied.

UAMMO(i) [6.14]

Cost per trainee of ammunition expended in unit training in year i.

UCONSU(i) [6.14]

Cost per trainee of miscellaneous consumables consumed in unit training in year i.

UCOPMT(i) [6.13]

Cost per trainee of maintenance of variable-cost unit training equipment in year i.

UCSQFT(i) [6.11]

Cost per square foot of operation and maintenance of unit training facilities in year i.

UCTNE(i) [6.1; 6.16]

Total cost of pay and allowances of trainees in unit training in year i.

UCTNR(i) [6.1; 6.15]

Total cost of pay and allowances of all trainers in unit training in year i.

UDACST(i) [6; 6.1]

Total non-discounted cost of unit training in year i.

UEAQCI(i) [6.1; 6.12; 6.2]

Total cost of unit training equipment acquisition in year i.

UEMQCI(i) [6.1; 6.13]

Total cost of unit training equipment maintenance in year i.

UEQCIS(i) [6.12]

Cost of fixed-cost equipment acquired for unit training in year i.

UEQIMP(i) [6.12]

Cost per trainee of variable-cost equipment used in unit training in year i.

UEQTRS(i) [6.17]

Cost per trainee for transportation of equipment used in unit training in year i.

UFACOS(i) [6.1; 6.2]

Total cost of unit training facilities acquisition in year i.

UFMCOS(i) [6.1; 6.11]

Total cost of unit maintenance of training facilities in year i.

UOMFEQ(i) [6.13]

Cost of operation and maintenance of fixed-cost unit training equipment in year i.

UPATNE(i) [6.16]

Average annual pay and allowances of trainees in unit training in year i.

UPATNR(i) [6.15]

Average annual pay and allowances of a trainer in unit training in year i.

UPETRO(i) [6.14]

Cost per trainee of petroleum products (POL) consumed in unit training in year i.

URVAST [6; 6.2]

Remaining value of facilities, equipment and instructional materials used in unit training at end of planning period (N years).

USQFTA [6.111]

Square feet of administrative facility space required to support unit training on the particular system being studied. If the space would be required even if the system were not being trained, this variable would be zero.

USQFTE [6.111]

Square feet per trainee of unit training facilities (assumed constant).

USQFTR [6.111]

Square feet of unit training facilities per trainer (assumed constant).

USUPPY(i) [6.1; 6.14]

Total cost of supplies consumed in unit training in year i.

UTIME [6.15; 6.16]

Fraction of year spent by each trainee in unit training until SQT is passed.

UTNRE [6.15]

Trainer to trainee ratio in unit training (assumed constant).

UTRANS(i) [6.1; 6.17]

Total cost of travel (including per diem) and equipment transportation in connection with unit training in year i.

UTRAVL(i) [6.17]

Cost per trainee for travel (including per diem) in connection with unit training in year i.

UTSQFT(i) [6.11; 6.111]

Total square feet of unit training facilities required in year i.

UVALUE [1; 3; 6]

The total training costs associated with unit training.

Appendix 2
LITTON COST MODEL SUMMARY

$$TVALUE = IVALUE + UVALUE \tag{1}$$

$$IVALUE = BVALUE + FVALUE \tag{2}$$

$$TVALUE = BVALUE + FVALUE + UVALUE \tag{3}$$

$$BVALUE = \sum_{i=1}^{N} \frac{BDACST(i)}{(i+d)^{(i-1)}} - \frac{BRVAST}{(1+d)^{N}} \tag{4}$$

$$BDACST(i) = BFACOS(i) + BFMCOS(i) + BEAQCI(i) + BEMQCI(i) + BACIMD(i) + BAIMMC(i) + BSUPPY(i) + BCINST(i) + BPALST(i) + BTRANS(i) \tag{4.1}$$

$$BFMCOS(i) = BTSQFT(i) \bullet BCSQFT(i) \tag{4.11}$$

$$BTSQFT(i) = [BSQFST + BINSTR \bullet SQFTIN] \bullet MESL(i) + BSQFTA \tag{4.111}$$

$$BEAQCI(i) = BEQIMP(i) \bullet MESL(i) + BEQCIS(i) \tag{4.12}$$

$$BEMQCI(i) = BCOPMT(i) \bullet SI(i) + BOMFEQ(i) \tag{4.13}$$

$$BACIMD(i) = BCIMD \bullet MESL(i) \bullet R \tag{4.14}$$

$$BAIMMC(i) = BCUIMD \bullet SI(i) \tag{4.15}$$

$$BSUPPY(i) = BSUPLY(i) \bullet SI(i) \tag{4.16}$$

$$BCINST(i) = [BPALIN(i) \bullet BINSTR \bullet MESL(i) + BOVERH(i) \bullet BRORAT(i) SI(i)] \bullet BTIME \tag{4.17}$$

$$BPALST(i) = ASTUPA(i) \bullet BTIME \bullet SI(i) \tag{4.18}$$

$$BTRANS(i) = BTRAVL(i) \bullet SI(i) + BEQTRS(i) \tag{4.19}$$

$$BRVAST = \sum_{i=1}^{N} \lfloor BFACOS(i) \rfloor \bullet [1-(FAD)\ (N-i+1] + [BEAQCI(i)] \lfloor 1-(EAD)\ (N-i+1)] + [BACIMD(i)] \bullet [1-(IAD)\ (N-i+1)] \quad (4.2)$$

$$FVALUE = \sum_{i=1}^{N} \frac{FDACST(i)}{(i+d)^{(i-1)}} - \frac{FRVAST}{(1+d)^{N}} \quad (5)$$

$$FDACST(i) = FEAQCI(i) + FEMQCI(i) + FSUPPY(i) + FCINST(i) + FPALST(i) + FPATRS(i) + FTRANS(i) \quad (5.1)$$

$$FEAQCI(i) = FEQIMP(i) \bullet SI(i) + FEQCIS(i) + FEQTRS(i) \quad (5.11)$$

$$FEMQCI(i) = FCOPMT(i) \bullet SI(i) + FOMFEQ(i) + FOMTRS(i) \quad (5.12)$$

$$FSUPPY(i) = \lfloor FPETRO(i) + FAMMO(i) + FCONSU(i)] \bullet SI(i) \quad (5.13)$$

$$FCINST(i) = FPALIN(i) \bullet FINSTR \bullet FTIME \bullet SI(i) \quad (5.14)$$

$$FPALST(i) = ASTUPA(i) \bullet FTIME \bullet SI(i) \quad (5.15)$$

$$FPATRS(i) = APATRS(i) \bullet FTIME \quad (5.16)$$

$$FRVAST = \sum_{i=1}^{N} \lfloor FEAQCI(i) \rfloor \bullet \lfloor 1-(EAD)\ (N-i+1)] \quad (5.2)$$

$$UVALUE = \sum_{i=1}^{N} \frac{UDACST(i)}{(1+d)^{(i-1)}} - \frac{URVAST}{(1+d)^{N}} \quad (6)$$

$$UDACST(i) = UFACOS(i) + UFMCOS(i) + UEAQCI(i) + UEMQCI(i) + USUPPY(i) + UCTNR(i) + UCTNE(i) + UTRANS(i) \quad (6.1)$$

$$UFMCOS(i) = UTSQFT(i) \bullet UCSQFT(i) \quad (6.11)$$

$$UTSQFT(i) = \lfloor USQFST + UTNRE \bullet USQFTR] \bullet METL(i) + USQFTA \quad (6.111)$$

$$UEAQCI(i) = UEQIMP(i) \bullet TU(i) + UEQCIS(i) \tag{6.12}$$

$$UEMQCI(i) = UCOPMT(i) \bullet TU(i) + UOMFEQ(i) \tag{6.13}$$

$$USUPPY(i) = [UPETRO(i) + UAMMO(i) + UNCONSU(i)] \bullet TU(i) \tag{6.14}$$

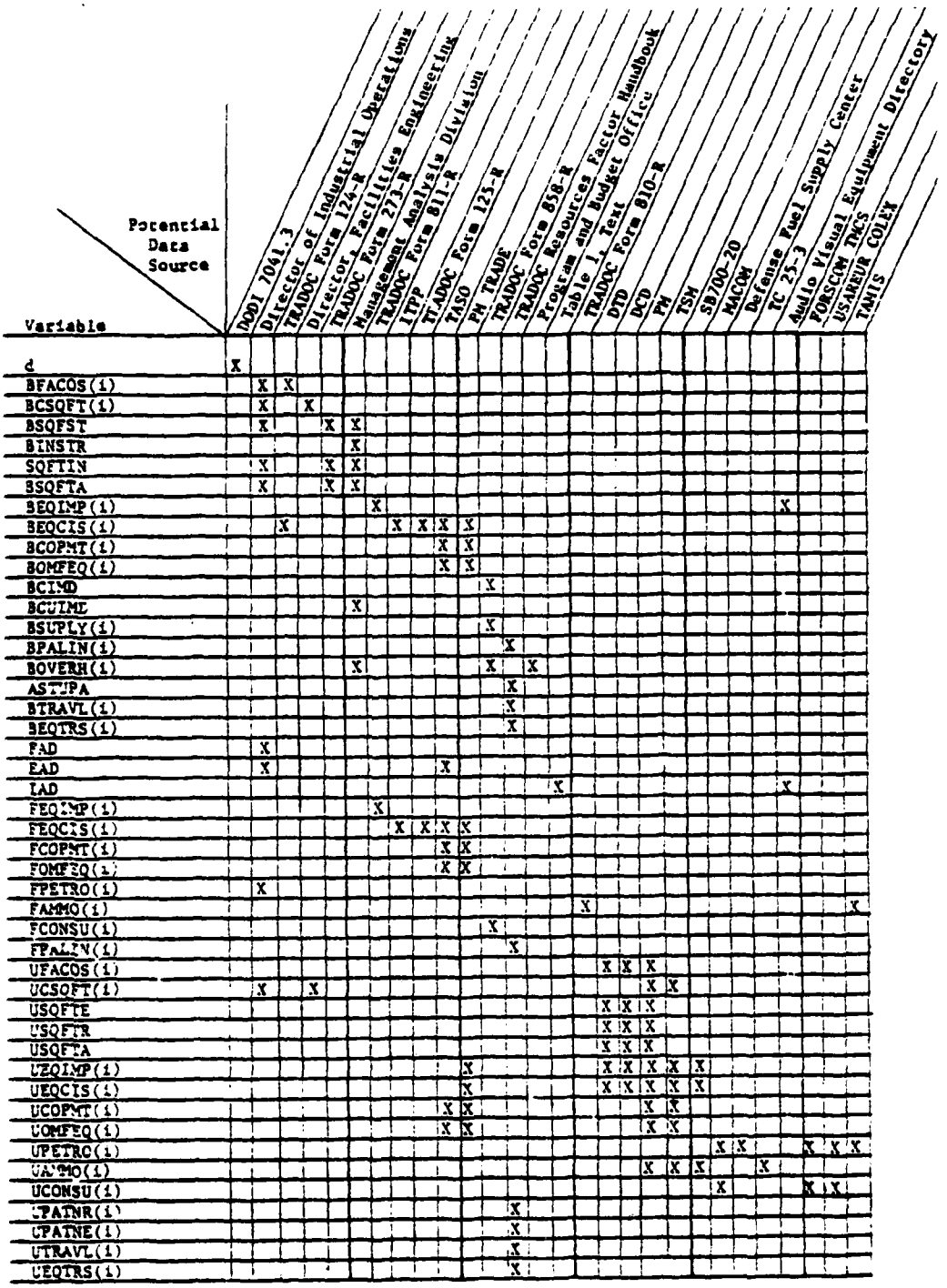
$$UCTNR(i) = UPATNR(i) \bullet UTNRE \bullet UTIME \bullet TU(i) \tag{6.15}$$

$$UCTNE = UPATNE(i) \bullet UTIME \bullet TU(i) \tag{6.16}$$

$$UTRANS(i) = UTRAVL(i) \bullet TU(i) + UEQTRS(i) \tag{6.17}$$

$$URVAST = \sum_{i=1}^{N} \lfloor UFACOS(i) \rfloor \bullet [1-(FAD)\ (N-i+1] + \lfloor UEAQCI(i) \rfloor \bullet [1-(EAD)\ (N-i+1)] \tag{6.2}$$

$$TPROGR = \sum_{j=1}^{M} TVALUE_J \tag{7}$$



Appendix 3 - Data Source Matrix

ANNEX E

TCA

TCA WORKSHEET

TASK NO. _____ ALT. ____

TASK DESCRIPTION

STIMULUS CHARACTERISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39

RESPONSE CHARACTERISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

FEEDBACK LOGIC

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

FUNCTIONAL CONTEXT

1	2	3	4	5	6	7	8	9	10	11	12	13

TRAINING DESCRIPTION

STIMULUS MEDIA

RESPONSE MEDIA

FEEDBACK MEDIA

METHODS

Appendix 1. TCA Worksheet

Appendix 2

Examples of Reasons for Including Variables in a Task Description (adapted from Hawley and Thomason, 1978).

Task 31.00 (Perform Monthly System Checks)

Variable Type, Number and Name	Reason for Inclusion
Stimulus Variables	
1. Visual Cues	Visual inspections made
2. Audio Cues	Auditory check of com. system
3. Tactile Cues	Tactile switch checks
8. Visual Alphanumeric	KPU printouts
9. Visual Symbolic	CRT display checks
10. Visual Graphic	CRT display checks
14. Visual Still	KPU printouts
15. Visual Limited Movement	Switch panels used
18. Black and White	KPU printouts
19. Gray Scale	CRT display
24. Bright Visual	Inspections made in good light
26. Voice Sound	Com. System
30. Strong Audio	Audio signals readily audible
32. Dynamic - Ordered	Inspection made in specified order
34. Slow Rate	Inspector proceeds at own speed
39. Group	Inspection conducted by crew
Response Variables	
1. Overt Response - Verbal	Some voice responses required
2. Overt Response - Written	Record results of system checks
3. Overt Response - Manipulation	Use of KPU, switches, etc.
5. Overt Response - Procedural	Specified inspection procedures used
7. Strong Response Intensity	Responses are definite

9.	Dynamic - Ordered Response	Responses are sequential
11.	Slow Response Rate	Inspector Responds at own rate
13.	Limited Response Channels	Response types are specified
16.	Group response	Inspection by crew

Feedback Variables

1.	Visual Feedback	Feedback from displays
3.	Written Feedback	Feedback from KPU
4.	Face-to-Face Comm.	Feedback from other crew members
10.	Intrinsic Feedback	Feedback modes built into system
15.	System Status	Feedback concerns system status
17.	Group Distribution	Inspection by crew

Methodological (Functional Context) Variables

1.	Supervisory	Senior Operator/Repairman supervises
5.	Physical	Inspection involves physical manipulations
6.	Perceptual	Perception of system responses required
7.	Communicative	Communication between crew required
9.	Stable Function	Procedure is specified and unchanging
10.	Low Physical Impact	Procedure unaffected by physical environment
12.	Low Psychological Impact	Procedure unaffected by psychological environment

NOTE: See Annex A (TEFM) for descriptions of these variables.

ANNEX F

LIST OF ABBREVIATIONS AND ACRONYMS

ANNEX F

LIST OF ABBREVIATIONS AND ACRONYMS

AD	Advanced Development
AIT	Advanced Individual Training
AP	Acquisition Plan
APM	Army Program Memorandum
AR	Army Regulation
ARTEP	Army Training and Evaluation Program
ASARC	Army Systems Acquisition Review Council
ASI	Additional Skill Identifier
ATM	Analogous Task Method
ATSC	Army Training Support Center (Fort Eustis, VA)
BDM/CARAF	The BDM Service Company Combined Arms Research and Analysis Facility
BOIP	Basis of Issue Plan
BOIPT	Basis of Issue Plan - Tentative
BT	Basic Training
CDB	Consolidated Data Base
C/E	Cost Effectiveness
CFP	Concept Formulation Package
CHRT	Coordinated Human Resources Technology
COEA	Cost and Operational Effectiveness Analysis
COI	Course of Instruction
COIP	Consequence of Inadequate Performance
CRT	Cathode Ray Tube
CTEA	Cost and Training Effectiveness Analysis
DA	Department of the Army

DARCOM	U.S. Army Materiel Development and Readiness Command
DCD	Department of Combat Developments
DCP	Decision Coordinating Paper
DIO	Director of Industrial Operations
DP	Development Plan
DRIMS	Diagnostic Rifle Marksmanship Simulators
DSARC	Defense System Acquisition Review Council
DT	Development Test
DT/OT	Development Test/Operational Test
DTD	Directorate of Training Developments
EEA	Essential Elements of Analysis
FYDP	Five Year Defense Plan
HRDT	Human Resources in Design Trade-Offs
ILS	Integrated Logistic Support
IPR	In-Process Review
IPS	Integrated Personnel Support
IRTA	Integrated Requirements and Tasks Analysis
ISD	Instructional Systems Development
ISP	Integrated Support Plan
ITC	Institutional Training Cost
ITDT	Integrated Technical Documentation and Training
ITP	Individual Training Plan
ITV	Improved TOW Vehicle
JGD	Job Guide Development
LCC	Life Cycle Costs
LCCE	Life Cycle Cost Elements
LCSMM	Life Cycle System Management Model

LOA	Letter of Agreement
LOGCEN	Logistics Center
LR	Letter Requirement
LSA	Logistic Support Analysis
LSAR	Logistic Support Analysis Record
MENS	Mission Element Needs Statement
MILPERCEN	Military Personnel Center
MMM	Maintenance Manpower Modeling
MOS	Military Occupational Specialty
MODIA	Method of Designing Instruction Alternatives
MOD	Modification
MOTE	Measures of Training Effectiveness
MPA	Military Personnel, Army
NET	New Equipment Training
OAP	Outline Acquisition Plan
ODP	Outline Development Plan
OICTP	Outline Individual Collective Training Plan
OJT	On-the-job Training
OMA	Operations and Maintenance, Army
OSUT	One Station Unit Training
OT	Operational Test
P_h	Probability of Hit
PIP	Product Improvement Program
PM	Project/Program/Product Manager
POI	Program of Instruction
POL	Petroleum, Oil and Lubricants
PPI	Plan Position Indicator

PQQPRI	Provisional Qualitative and Quantitative Personnel Requirements Information
PROC	Procurement
QQPRI	Qualitative and Quantitative Personnel Requirements Information
RAM	Reliability, Availability, Maintainability
RDTE	Research, Development, Test and Evaluation
RFA	Rimfire Adapter
ROC	Required Operational Capability
RTE	Relative Training Effectiveness
RUM	Resource Utilization Model
SAT	Systems Approach to Training
SOC	System Ownership Cost
SQT	Skill Qualification Test
TASA	Task and Skill Analysis
TASC	Training Aids Service Center
TASO	Training Aids Service Office
TAEG	Training Analysis and Evaluation Group
TCA	Training Consonance Analysis
TCR	Training Consonance Ratio
TEC	Training Extension Course
TECEP	Training Evaluation Cost Evaluation Program
TDDA	Training Developers Decision Aid
TDIS	Training Developments Information System
TDR	Training Device Requirement
TDT	Task Delay Tolerance
TEEM	Training Efficiency Estimation Model
TLD	Task Learning Difficulty

TM	Technical Manual
TMON	Technical Manual on
TOCI	Training Option Cost Indicator
TOE	Table of Organization and Equipment
TQQPRI	Tentative Qualitative and Quantitative Personnel Requirements Information
TRADOC	Training and Doctrine Command
TRAINVICE	Training Device Effectiveness Model
TRAM	Training Analysis Model
TRAMOD	Training Requirements Analysis Model
TSD	Training System Design
TSM	TRADOC System Manager
TTC	Total Training Cost
UI	User Interface
UTC	Unit Training Cost
WSTEA	Weapon System Effectiveness Analysis

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5 May 81

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R81-0951

Litton Systems Inc - Sunnyvale, CA

Subject Area: Development of a Cost Training Effectiveness Manual for Use in Army Life Cycle Systems Management Model (U)

*MDA903-79-C-0326 - All tech reports generated on cited contract including the final report.

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C Jorgensen
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